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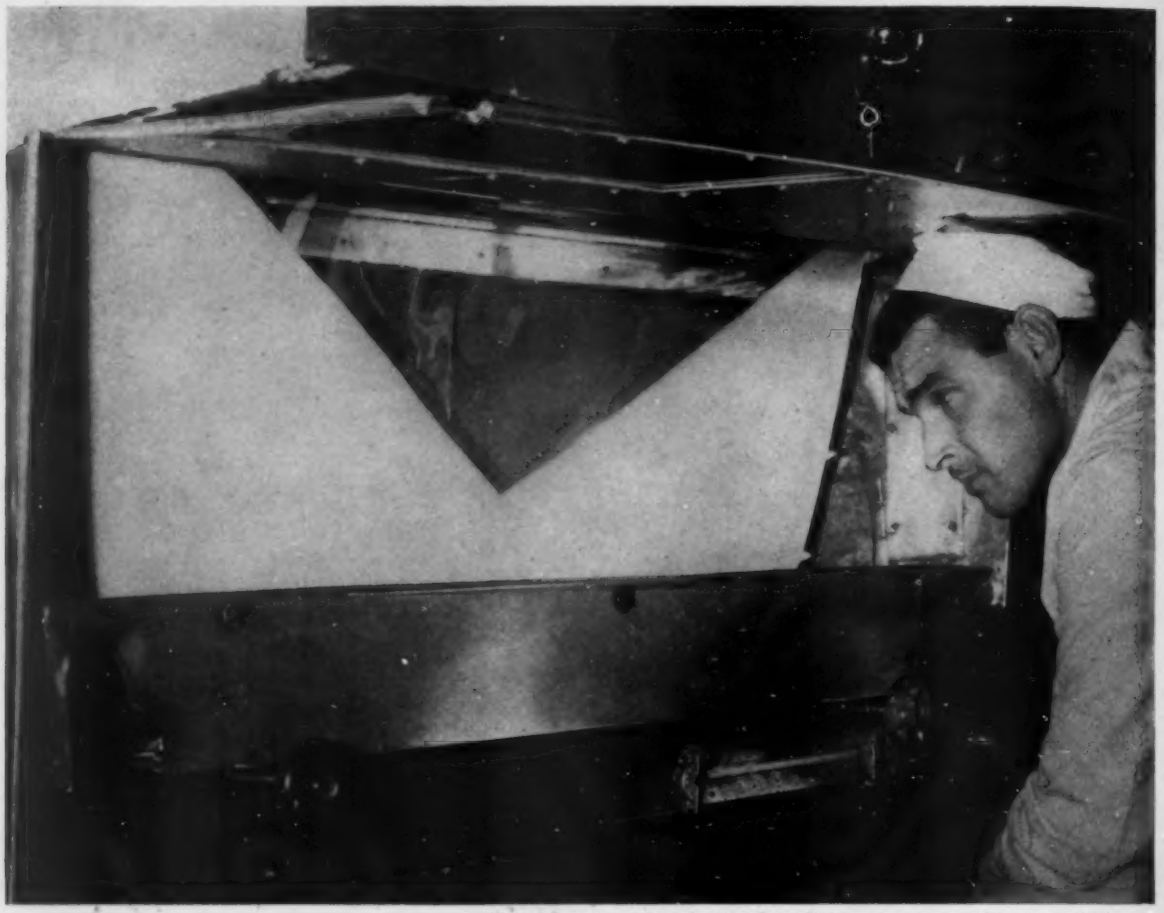

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Vol. 54 OCTOBER, 1945 No. 4

DIFFERENTIAL DIAGNOSIS OF TUBERCULOSIS IN JOINTS OF THE EXTREMITIES*

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Roentgenologist to the Hospital for Special Surgery

NEW YORK, NEW YORK

AS LONG ago as 1924, in roentgenological and surgical journals, Phemister[1,2] recorded points which still stand as the principal distinguishing features of tuberculous and non-tuberculous suppurative arthritis. Since it appears that these criteria are not so widely known or so generally employed as their importance warrants, restatement and further illustrations seem indicated.

In his articles Phemister wrote that in pyogenic (non-tuberculous) arthritis, the articular cartilage is killed and broken down first at the points of contact and pressure of opposing articular surfaces; that in these infections proteolytic ferments assist greatly in the rapid removal of the necrotic cartilage. In terms of roentgenology, this means that in pyogenic arthritis there is early narrowing or disappearance of the joint space, and the earliest bone destruction occurs on the opposing, or weight-bearing, portions of the articular surfaces.

In contrast with this, Phemister notes that in tuberculous arthritis the articular cartilage is not killed first, but rather is protected at the points of contact and pressure of opposing articular surfaces; that its earliest destruction is peripheral, along the free surfaces where tuberculous granulations can grow onto and remove it. Proteolytic ferments, present in pyogenic infec-

FIG. 1. Tissue excised from a tuberculous joint. The articular cartilage is dead and detached from the bone, and lies unabsorbed in the joint. The pathologic process illustrates how the joint width is maintained by the persistence of the cartilage even though dead. (Courtesy of Dr. Milton Helpern, Director of Laboratories.)

* Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

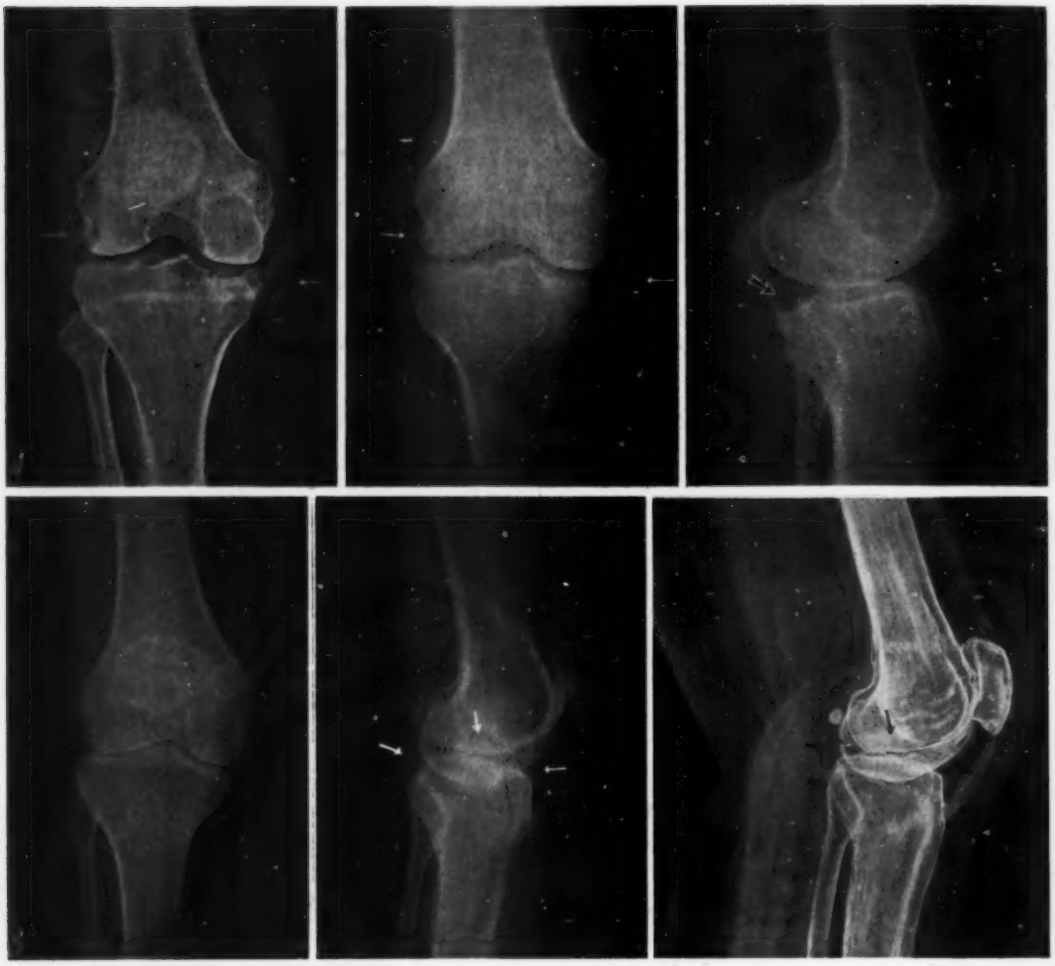

Fig. 2. Characteristic examples of proved tuberculous and non-tuberculous arthritis.

A, tuberculosis: marked synovitis, well preserved joint width, slight bone destruction at the margins of the weight-bearing portions of the articular surfaces. T. McK., male, aged twenty-seven, pain and disability in the right knee of two years' duration. Easily recognized roentgenographically as tuberculosis. Specimen removed at operation reported tuberculosis by the pathologist.

B, non-tuberculosis: marked synovitis, narrowed joint space, slight bony erosion on the weight-bearing portions of the articular surfaces. B. C., female, aged forty-seven, pain and swelling of right knee of ten years' duration. Sent to the hospital as suspicious of tuberculosis. Diagnosed roentgenologically as non-tuberculous arthritis. Report of pathologist on specimen removed at operation: chronic proliferative synovitis.

tions, are absent in tuberculous arthritis, and masses of dead cartilage may persist for months or years, showing few signs of progressive destruction. The first disappearance of the bony cortical shadow (that is, bone destruction) is usually seen peripherally, about the margins of the weight-bearing portions of the articular surfaces, where there has been absorption by the granulations. These observations, in terms of roentgenology, mean that in tuberculous arthritis there is preservation of the joint width for months or years, since the cartilages, though dead, are still present to hold the bones apart; and that the earliest bone destruction is not on the contiguous opposing bony surfaces, but about the margins of the weight-bearing surfaces.

FIG. 3. Proved case, recognizable roentgenographically as early tuberculosis. Roentgen findings: Severe synovitis, joint space well preserved, small areas of bone roughening and deposit anteriorly, posteriorly, and medially at the margins of the upper tibial articular surface. History: R. D., male, aged twenty-one, had spent eight months in a sanatorium because of pulmonary tuberculosis. Four months ago struck his left knee, since when he has had pain and swelling. Roentgen report: strongly suggestive of tuberculosis. Pathologist's report: tuberculous synovitis.

To these primary points of differentiation may be added a few other distinguishing characteristics: (1) in acute suppurative arthritis occurs rapid and severe osteoporosis immediately about the joint, doubtless the result of the acute congestion of the

FIG. 4. Proved tuberculosis in a child, showing that the pathological processes and roentgenographic findings are essentially as in adults. History: F. F., female, aged four, had for the past twenty months been under treatment at this hospital for tuberculosis of the ankle joint, with onset of symptoms twenty-one months ago, and with the diagnosis established three months after onset by guinea pig inoculation of fluid aspirated from the ankle joint. Roentgen examination twenty-one months after the onset of symptoms (*A*) showed marked synovitis, no narrowing of the joint space, no evidence of bone destruction. Shortly after this, the patient left the hospital for a six year interval, eventually returning only because of weak feet. At this time she had no complaint with reference to the ankle, and physical examination and roentgenographic examination gave no suggestion of present or recent activity. The disease was either quiescent or cured. Roentgenographically (*B*) the joint width was found normal, there was slight old irregularity of the bones.

Comment. In a case of proved tuberculosis of the ankle joint in a child, followed for two years and then re-examined six years later when the disease was either quiescent or cured, there was never narrowing of the joint space.

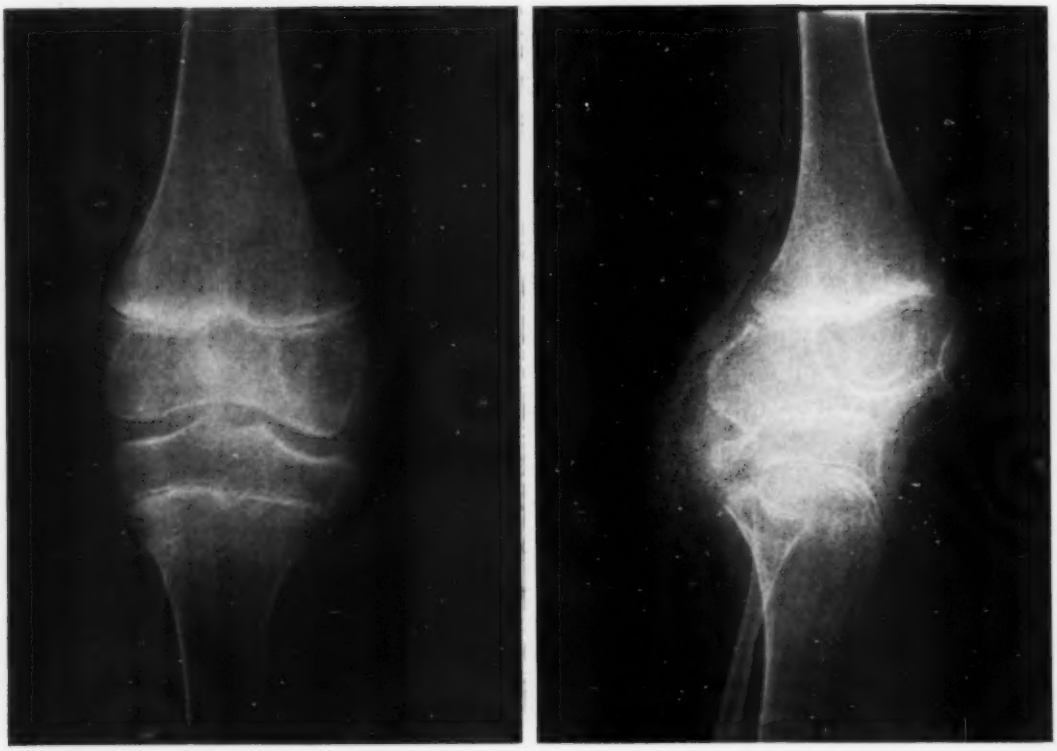

Fig. 5. D. DeM., male, aged nine. Tuberculosis of the knee joint, proved by injection into a guinea pig of material aspirated from the joint. The roentgenogram two and a half years after onset of the disease shows marked synovitis, no narrowing of the joint width, bone erosion too slight to determine its precise location.

Fig. 6. Early tuberculosis of the wrist joint, following tuberculous tenosynovitis of five to six years' duration. Roentgenogram shows small area of bone erosion on the proximal surface of the scaphoid tuberosity, just

part. This rapid and marked osteoporosis is usually lacking in tuberculosis, which is a "cold" infection, not characterized by vascular engorgement; (2) acute pyogenic joints show a distinct tendency to repair and ankylosis, features which are customarily absent in tuberculosis; (3) in tuberculosis the adjacent muscles frequently show marked atrophy, which is not the case in acute pyogenic infection.

To summarize: In acute suppurative arthritis we find acute osteoporosis, early

Fig. 7. Unproved, but probably early tuberculosis of the wrist joint. Shown because of similarity to the preceding case. History: S. N., female, aged forty-eight, complained of pain and swelling of the wrist for three months. Roentgen findings: Soft tissue swelling about the wrist, small area of erosion on the waist of the scaphoid bone at the margin of the articular surface, no narrowing of the joint width, widely distributed homogeneous osteoporosis, atrophy of the lower forearm. The patient left the clinic and placed herself under the care of an orthopedic surgeon in a neighboring borough. A letter from him seven months later reported that he had been unable to confirm or disprove the diagnosis of tuberculosis, but that the clinical course gave much evidence for confirmation.

Comment. The clinical course and the characteristic roentgen findings, in the light of the preceding case, seem to warrant a provisional diagnosis of tuberculosis.

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at the margin of the articular surface. No decrease in joint width. History: S. K., male, aged fifty-six, history of swelling of the wrist for five to six years. Clinical diagnosis, tuberculous tenosynovitis of flexor tendons at the wrist. Roentgen findings supported this diagnosis, but also showed the scaphoid erosion, the serious import of which none of us fully appreciated. The tendon sheaths were removed successfully at operation, and the diagnosis of tuberculosis was confirmed by the pathologist. Unfortunately the tuberculosis of the wrist joint progressed rapidly, and upon examination roentgenographically seventeen months after operation the disease was found far advanced.

decrease in the joint width, bone destruction first on the weight-bearing portions of the articular surfaces, usually little atrophy of adjacent muscles, a distinct tendency to repair and ankylosis after the early destructive stage. In tuberculosis we find less osteoporosis, late persistence of the joint width, bone destruction first peripherally on the non-weight-bearing portions of the articular surfaces, usually considerable muscle atrophy, little tendency toward repair and ankylosis.

Fig. 8. Proved case, recognizable roentgenographically as tuberculosis. Roentgen findings: Considerable soft tissue swelling, good preservation of joint space, areas of bone erosion on the lateral aspect of the lateral humeral condyle, at the lateral margin of the capitellum, and on the lateral border of the radial head. History: S. G., male, aged fifty, with complaint of limitation of motion and swelling of the elbow for about two years. Guinea pig inoculation of aspirated material was positive for tuberculosis. In spite of immobilization in plaster and a winter spent in Florida, the destructive process was found to have progressed very markedly when he was examined roentgenographically sixteen months later.

If these infections would always follow their textbook patterns and show their characteristic features, recognition would be exceedingly simple. Unfortunately, however, there are so many variables due to differences in virulence in the invading organisms and reactions in the hosts, that disease characteristics often become greatly interchanged, the roentgen findings are far from clear cut, and the baffled roentgenologist can only cast his diagnostic vote on the basis of majority evidence and hope he is right.

Another confusing element in the differential diagnosis is an apparent difference in the roentgen manifestations in certain joints. In hips, for example, we have seldom observed the criteria established by Phemister; and our earliest recognition of tuberculosis in this location is usually on the basis of a more or less chronic destructive disease of bone and cartilage, with little or no evidence of repair. And this, I am sure, is a fairly late stage. Although there might be an actual difference in the pattern of disease invasion of this joint, due to differences in anatomy and function, the more probable explanation is that we fail in this joint to show those early manifestations of the disease which we are successful in depicting in the more distal and much more accessible joints.

Further difficulty in diagnosis is introduced by that manifestation of joint tuber-

Fig. 9. To show that other conditions may simulate tuberculosis, and as a warning against overconfidence in roentgen diagnosis. Proved case of lymphatic leukemia of the elbow joint, presenting the roentgen characteristics of moderately advanced tuberculosis. History: C. D., male, aged fifty-three, developed pain and swelling in the right elbow three and a half months ago. About two weeks after onset, his private physician made an incision, under gas anesthesia, and pus was said to have been evacuated. Since that time the wound has drained. Upon presenting himself to the clinic the patient complained of a swollen, functionless elbow, draining slightly from a sinus. There were no systemic symptoms.

Roentgenograms (*A*) showed a markedly swollen elbow, with extensive old destruction of the articular surfaces, without repair other than slight productive changes about the neck of the radius, with preservation of the joint space. The condition was believed almost certainly to be extensive old tuberculosis. A diagnosis of lymphatic leukemia was established by blood count and examination of a lymph node excised from the axilla. Radiation treatment was given at Memorial Hospital. The patient was seen at follow-up examination eighteen months later, his general condition was found good, he had good elbow function, he had been working for a year, his blood count was still characteristic of lymphatic leukemia, the roentgenogram (*B*) showed excellent healing and no evidence of any present disease.

Fig. 10. Unproved, but beyond doubt tuberculosis of the shoulder joint, in a patient with widely distributed proved tuberculosis. Roentgen findings: Soft tissue swelling, joint width preserved, area of bone destruction and reaction at and about the medial margin of the humeral articular surface. History: E. U., Negro, aged twenty-one, was operated upon for an undiagnosed destructive and productive lesion of the tibial shaft. The disease spread into the knee joint, which was operated upon twice, and then thigh amputation was performed. Pathologist's report: Bone and synovial tuberculosis. The patient developed several other foci in the extremities, including the shoulder, and developed pulmonary involvement, with positive roentgen findings and sputum, from which he died.

culosis commonly called caries sicca. The reasons for the occasional occurrence of this quite different pattern of tuberculous invasion are apparently unknown. In our rather limited experience with it, we have sometimes been successful in diagnosis, largely by process of elimination: a single joint, with varying degrees of rounded punched out bony erosion and rounded bony excavation in and about the joint, with fairly good preservation of cartilage, with no suggestion of repair, with little or no soft tissue reaction,—what else might it well be?

Fig. 11. Rather typical case of proved tuberculosis of the hip joint, showing that the usual roentgen diagnostic criteria are not, as a rule, demonstrable in this joint. Roentgen findings: Striking demineralization of the bones, with especially poor bone detail in the upper hemisphere of the femoral head, with good preservation of the joint width (this is often not true), with soft tissue swelling. This could be identified only as a low grade destructive type of arthritis with no repair, suggestive but not definitely positive of tuberculosis. History: F. DeG., female, aged thirty-one, came to the clinic with nine months' history of pain and stiffness in the hip. She was roentgenographed and followed in the clinic and hospital for eight months before she developed sufficient roentgen evidence to warrant surgical intervention. Microscopic study of removed tissue established the diagnosis.

Comment: In the hip joint roentgen findings pathognomonic of tuberculosis are not the rule. The disease may be suspected when there are evidences of monarticular chronic destructive infectious arthritis.

Of diseases other than acute suppurative arthritis with which tuberculosis of the joints of extremities might be confused, little need be said. The appearance of rheumatoid arthritis is quite different, and many joints are involved. There is ordinarily no confusion with neuropathic joints, where the destruction is largely mechanical. With luetic joints other than Charcot, I have little familiarity. Villonodular synovitis produces a large boggy joint, with no suggestion of bone or cartilage abnormality, and not even osteoporosis. Of rare joint involvements in leukemia, histoplasmosis,

Fig. 12. Proved case of tuberculosis, classified by us as of the caries sicca type. The usual roentgen diagnostic criteria are not applicable in cases of caries sicca. Roentgen findings: Extensive old rounded punched-out areas of bone destruction in the acetabulum and femoral head, with moderate narrowing of the joint width, and little if any soft tissue swelling. History: N. P., male, aged fourteen, gave a history of some pain and disability in the hip and knee for five years, but never sufficiently severe to interfere with school athletics or other activities. He had never consulted a physician until one month ago. Our comment on the above roentgen examination: the findings are suggestive of caries sicca. At operation the joint capsule was found thickened and villous, the joint cartilages were somewhat thin and yellowish but were not detached nor necrotic, the outer border of the acetabulum was irregular and eburnated. There was no mention of any fluid in the joint. Report of the pathologist on tissue removed: tuberculosis of synovium and bone.

and so forth, one can say only that they are confusing, they should be borne in mind, and that their diagnosis rests mostly on evidence other than roentgenologic.

SUMMARY

1. Phemister's significant work on tuberculous and pyogenic infections of the joints of extremities, so far as this applies to roentgenographic differential diagnosis, has been reviewed.

2. Roentgenographic characteristics of pyogenic (non-tuberculous) infections of extremity joints are: acute osteoporosis, early decrease in joint width, earliest bone destruction on weight-bearing portions of articular surfaces, usually little atrophy of muscles, a tendency to repair and ankylosis.

3. Characteristics of tuberculosis: less osteoporosis, late persistence of joint width, earliest bone destruction peripherally about the margins of the weight-bearing surfaces, usually considerable muscle atrophy, little tendency to repair and ankylosis.

4. These differential points appear not to apply to hip joint infections, or to cases of caries sicca.

5. Lymphatic leukemia, and probably other conditions, may simulate tuberculous arthritis.

6. Illustrative cases have been presented.*

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New York, N. Y.

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* For discussion see page 354.

INTERNAL DERANGEMENTS OF THE KNEE JOINT

THE DIAGNOSTIC SCOPE OF SOFT TISSUE ROENTGEN EXAMINATIONS AND THE VACUUM TECHNIQUE DEMONSTRATION OF THE MENISCI*

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THE roentgen examination of that large group of patients with derangements of the knee joint could be made indispensable if roentgenologists would heed Carty,[3] Ferguson,[7] Lewis,[9] Dittmar,[4] Nordheim,[11] Evans,[5] and others,[10] who have proved the value of soft tissue and meniscus studies.

Among the soft structures which can be demonstrated in the knee joint are the skin, the subcutaneous layer with its large veins, the rectus femoris, the vasti, the suprapatellar space, the patellar ligament, the infrapatellar fat pad and its extensions, the gastrocnemius and hamstring tendons, the adductor muscle and its tendon, the cartilage lining of the joint, the tibial collateral ligament, the extracapsular bursae when distended, and finally, the menisci.

Special techniques, as advised by Carty,[3] are not necessary for the examination of the soft structures; Lewis[9] also held that special techniques are not essential. By limiting the routine examination of the knee to anteroposterior and lateral views, the roentgenologist is deprived of essential information which can be obtained if a longitudinal view of the patella and bilateral views of the menisci are included. If any abnormal findings are disclosed by such examinations, additional oblique and so-called intercondylar views may be added. Since the light from an ordinary view box may not have the proper intensity for revealing the soft tissue shadows, a special light source which can be regulated in varying steps of light intensities will be found useful. One of the greatest needs of the roentgenologist is a source of light in his viewing equipment which has wide variable intensities and whose field of illumination can be regulated in size and shape for optimum visualization of soft structure outlines.

The internal meniscus may be demonstrated simply by traction or abduction of the leg. It is our practice to place the patient in the recumbent position on his side, with a sand bag between the table and the lateral aspect of the knee to be examined. A horizontal roentgen-ray beam is directed anteroposteriorly through the knee while a technician forces the leg into abduction against the table top. The exposure is made two or three seconds after the initiation of abduction because, if made earlier or later, the full vacuum is not revealed due to incomplete dispersion or to filling up of the joint space with synovial fluid. A lateral view of the meniscus can be obtained as easily as the anteroposterior view, using the same technical principles, but since no additional information is derived, our routine examination is limited to bilateral anteroposterior views. No clinical significance is attached to irregular margins or defects of menisci since such changes are not uncommonly visible in the healthy knee joint. It is only non-visualization of the meniscus which carries diagnostic weight because synovial fluid in the slightest excess makes demonstration of the meniscus impossible. Nordheim[11] believed that the meniscus could not be shown if more than 5 or 10 cc. of fluid was present in the knee joint. In normal cases, the internal meniscus can be demonstrated in not more than 80 per cent of cases. The external meniscus can be shown in not more than 20 per cent. If, therefore, the meniscus cannot be de-

* Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

monstrated in either knee joint, it is presumed that the patient falls into the small 20 per cent group in which the internal meniscus cannot be demonstrated normally. To illustrate, suppose one is called upon to examine a football player whose knee had locked during a recent scrimmage. If the meniscus in the injured knee cannot be demonstrated while the meniscus in the healthy knee can be demonstrated, these findings are taken to indicate the presence of excess synovial fluid in the injured knee, even though there is no clinical evidence of swelling. If the meniscus in either knee

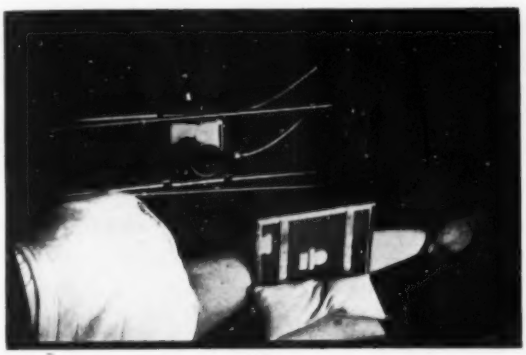

Fig. 1. Technique for the examination of the internal meniscus. A sand bag may be placed under the lateral aspect of the knee to be examined with the patient in the lateral recumbent position and while a technician abducts the extended leg by pressing the ankle towards the table top, an anteroposterior exposure of the knee joint is made, directing the roentgen-ray beam horizontally.

cannot be demonstrated, then these findings have no value.

Slight excess synovial fluid may be present without clinical detection in cases of chronic as well as acute injury or disease, so that it is our practice to make bilateral meniscus examinations a routine procedure in all examinations of the knee.

The quality of the roentgen diagnosis will depend on the care with which all the clinical facts are gathered and appraised. Presuming an intimate knowledge of the appearance of the normal soft tissue structures, in the light of a well documented history and physical examination, the slightest irregularities in the roentgenogram can be interpreted properly in pathologic terms leading to a precise diagnosis and prognosis. This averts making a roentgenologic report describing shadows in vague meaningless terms which hedge the diagnosis until the value of the roentgenologic consultation has been reduced to a minimum, if not rendered discouragingly ambiguous.

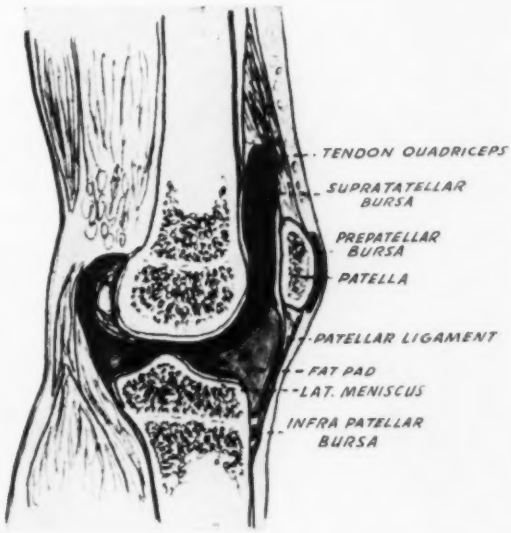

Fig. 2. Soft structures of the knee joint which can be studied roentgenographically in the lateral view.

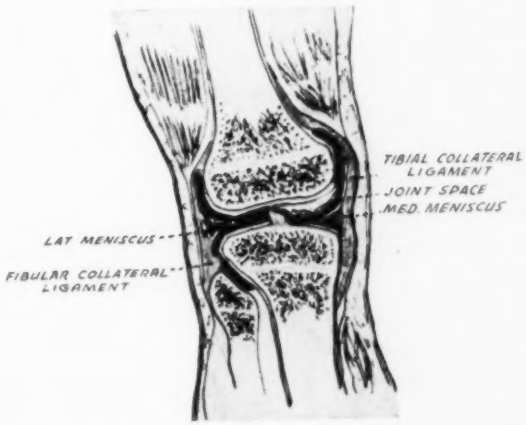

Fig. 3. Soft structures of the knee joint which can be studied roentgenographically in the anteroposterior view.

The finding of slight excess synovial fluid

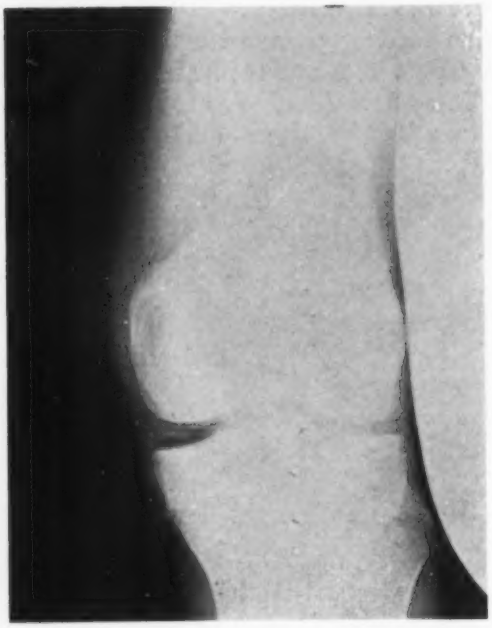

FIG. 4. Normal internal meniscus, tibial collateral ligament, subcutaneous layer, long saphenous vein and skin over inner aspect of knee joint.

in an acutely injured knee, evidenced by a failure to demonstrate the meniscus, suggests that the roentgenologist look for abnormal changes in the soft structures if he is to report findings which explain the patients' symptoms. There may be an actual fracture or loosening of the attachments of a meniscus, especially if there is swelling of the tibial collateral ligament; or there may be a swelling of the tibial collateral ligament resulting from a sprain. The structures in the region of the tibial collateral ligament are seen best in the anteroposterior and lateral views. If both knees are examined, the untrained observer can compare the injured with the healthy side and readily determine the slightest swelling in this area. This is important because most actual injuries to the internal meniscus are associated with sprain and swelling of the tibial collateral ligament. In cases where there has been damage to the anterior horn of the internal meniscus, there is frequently an associated injury to the inner alar fat pad. When all the symptoms of internal derangement are present except that of locking, damage to the alar fat pad might be the explanation and this can be seen as a swelling on the inner side of the patella in the longitudinal view. If there has been only a rupture or a sprain of the tibial collateral ligament, a localized swelling of the ligament may be seen corresponding to the point of greatest pain and tenderness. Occasionally, the demonstration of the meniscus in a swollen knee will indicate the absence of excess synovial fluid; the swelling in these cases may be found to be due to subcutaneous edema, enlargement of bursae, periosteal damage or hemorrhage, a torn ligament, cysts, or hypertrophied fat pads. Such precise differentiation, not possible by physical examination, can be made by careful roentgen examination of the soft structures.

INTERNAL DERANGEMENTS OF THE KNEE JOINT

The attachments of the menisci vary widely and this markedly influences the symptomatology. Thus one individual may

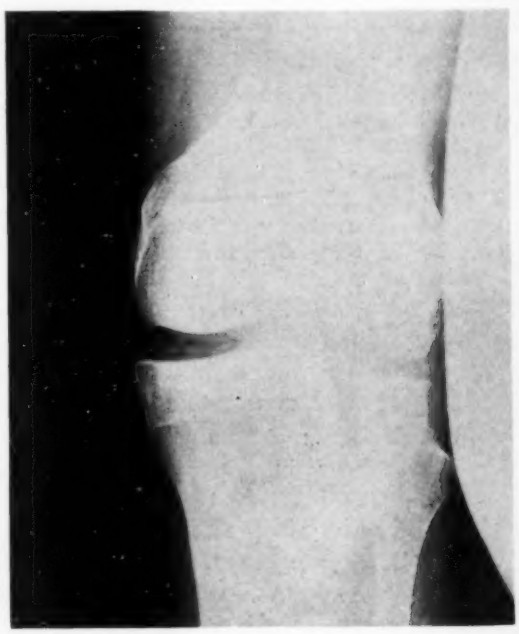

FIG. 5. A sagittal defect of the internal meniscus suggesting a bucket-handle fracture, but this knee joint was symptomless and supposedly healthy. This patient was examined because of an injury to the opposite knee which revealed a prepatellar contusion resulting from a bump of the knee against the dashboard of an automobile.

wrench his knee severely without displacement of the cartilage and another may have displacement simply with ordinary use on a staircase or on the dance floor. The congenital anomalies naturally produce symptoms early in life and those that appear in childhood are apt to be due to these congenital irregularities, especially common in the external disc. The highest incidence of symptoms occurs in the age group between fifteen and twenty-five years. In a large number of cases encountered in a relatively short time at a Naval Training Center recently, more than 60 per cent of the cases fell into this age group; but even when the statistics are culled from the civilian population, similar findings have usually been made. Athletics is the principal immediate cause of symptoms in most cases, usually football, basketball or drill maneuvers. In some occupations, as mining, especially in the low gallery mines of England where miners work in a kneeling position with their toes turned out, there is also a high incidence of chronic internal derangement of the knees.

The initial symptoms may be sudden, severe and intense and then become progressively less disabling with each recurrence; or the first symptoms may be almost insignificant, but with each recurrence they may become progressively more severe. Again, the symptoms of the first attack may be mild and change slightly in character during the chronic recurrent phases of the disease. Finally, in some instances, the initial symptoms may be severe and remain so with few remissions. These various trends in the course of the disease depend chiefly on the structural characteristics of the joint ligaments and the nature of the initiating mechanism. An intense acute onset is due usually to concomitant damage to the ligaments. Locking, which does not occur until late, may be the result of progressive stretching of the ligaments with each recurrent attack. Whether locking occurs early or late in the course of derangements, the acuteness of the symptoms is usually due to the initial sprain and swelling of the ligaments. Some care must be exercised in

Fig. 6. Internal derangement of the knee joint resulting from a football injury which caused locking. There is slight swelling of the synovia and of the mid-portion of the tibial collateral ligament. The presence of slight excess fluid in the joint space precluded demonstration of the meniscus by the "vacuum technique." At operation, the surgeon (Dr. M. A. Stevens) found a detachment of the posterior horn of the internal meniscus.

getting the facts about locking; limitation of motion is sudden and immediate in disc injuries whereas limitation of motion due to effusion, pain or spasm comes on gradually. Conversely, a sudden "unlocking" is characteristic of a released interposed torn meniscus fragment, while gradual restoration of full knee motion is associated with resolution of a synovial effusion and muscular spasm. In football injuries true locking occurs in 60 to 80 per cent of cases but the incidence from other accidents, such as a fall, a blow or a twist is relatively low, probably less than 25 per cent. Tenderness is usually localized over the site of the torn portion of the meniscus, whereas the tenderness which may be found with effusion is usually not localized. The mere presence of local tenderness is not always indicative of a torn cartilage, because local tenderness may also occur over a tear of the tibial collateral ligament or over a localized contusion. Since all these conditions may be associated with synovial effusion, the

differential diagnosis of a torn meniscus may be difficult or even impossible in the early stages, especially in those cases where there is no history of locking. In a recent analysis of 84 cases of ruptured menisci proved by operation, the history disclosed locking in 60 per cent, "giving way" of the knee in over 20 per cent, pain in slightly under 20 per cent and effusion in about 20 per cent.

A careful clinical examination may lead to the proper diagnosis without a roentgen examination, but its omission can deprive the clinician of extremely valuable information. In uncomplicated injury to a meniscus, swelling of the synovia with excess synovial fluid, swelling of the tibial collateral ligament and inability to demonstrate the internal meniscus by the vacuum technique may be the only roentgen findings in support of the clinical diagnosis; but it is the absence of other roentgen evidence of disease which may be of even greater importance to the clinician in the treatment of these cases.

LOOSE BODIES

Loose bodies may be single or multiple, pedunculated or free, laminated or non-laminated and they may originate from unorganized fibrin, necrotic portions of synovial membrane, organized connective tissue, cartilage or bone. Hemorrhage into a joint may be a source of fibrin, later forming a loose body. Necrotic synovia, part of an arthritic process, may be another source of loose bodies. This is quite common in tuberculosis which is associated with loose bodies that have ragged margins and shaggy surfaces at first, but which soon become smooth and glistening, not unlike melon seeds in appearance. Some loose bodies originating from hypertrophied synovial fringes may be due to trauma, synovitis or osteoarthritis; others originate from hypertrophied fat pads as lipomas before becoming detached. Loose bodies due to bone or cartilage are usually of arthritic origin, but they may come from normal joint structures from which they have become detached by direct or indirect trauma. Many chondromas are of synovial origin. Shattock,[12] in 1889, pointed out the derivation of other loose bodies from areas of hyperplasia in cartilage in which central ossification subsequently occurs. Of the arthritic causes, tabes produces the largest loose bodies whereas infectious non-tuberculous forms of arthritis may produce only small bony sequestra or flakes of necrotic articular cartilage.

Loose bodies occurring in normal joints by detachment of the articular surface are seen more frequently in males than in females, and usually between fifteen and twenty-five years of age. The convex surface of these bodies, which may be oval and about the size of an almond, is apt to be smooth, while the opposite surface is rough and wrinkled. They arise usually from the under surface of the inner femoral condyle or from the posterior surface of the patella and while they are commonly single, two or more are seen occasionally in the knee joint. These bodies may be only incompletely detached, but when fully detached and free, a defect in the articular surface at the site of their origin may be seen having the same size and shape as the body; this condition is often seen bilaterally.

Loose bodies due to synovial chondromas may be single, multiple or diffuse, pedunculated or free. Although these bodies may arise from cartilage cells normally present in the synovia, they usually come more often from the connective tissue cells of the membrane. The single chondroma may or may not be laminated and the surface is usually smooth, even if made up of low lobulations. The laminated chondromas tend to occupy pouches or recesses of the synovial membrane, and because they usually grow larger than most other loose bodies, they seldom get caught between the articular surfaces. Fisher[8] believed that some loose bodies may be due either to direct traumatic detachments or to separation of portions of the articular surface by a pathologic process following injury, similar to a localized form of traumatic osteo-

arthritis. Shattock[12] called these formations "epiarticular ecchondroses" while König called the condition "osteochondritis dissecans." The concept is held by many that trauma is at least one factor in this condition just as it is conceivable that by indirect strain with violent pull on the cruciate ligaments, detachment of a small portion of the articular surface might be effected.

The clinical diagnosis of loose bodies is based on the history of sudden attacks of severe pain, often followed by swelling or momentary locking, due to the body becoming suddenly nipped either between the articular surfaces or between the capsule and joint ends. The momentary locking may be associated with the presence of external swelling, and the patient may make this observation and find it necessary to push the body inward to free the joint. Large bodies may give rise to less acute symptoms since they are unable to engage themselves between the articular surfaces. Those bodies which remain firmly attached to the synovia or in pockets of the articular surface without getting pinched between the articular edges seldom if ever cause symptoms.

The roentgen demonstration of loose bodies in anteroposterior and lateral views of the knee is not easy even when they are calcified or ossified. The longitudinal view of the patella, oblique and lateral views in extension and flexion in over-exposed films are necessary to furnish all the available roentgenologic evidence in the detection of loose bodies, especially in those bodies still undetached in the cartilage layer. Thickening of the synovia due to diffuse hyperplasia can be seen by careful attention to the soft tissue shadows, and this furnishes a clue to the presence of chondromata which might be felt but which cannot be seen in the roentgenograms. Other invisible loose bodies, derived by trauma from the articular cartilage, may be suspected after finding defects in the cartilaginous outline of the femoral condyles and the patella, especially in the longitudinal view. The meniscus

Fig. 7. An old rupture and chronic sprain of the tibial collateral ligament. There is periosteal proliferation and calcification of hemorrhagic infiltration around the lower attachment of the swollen tibial collateral ligament. A football injury, which occurred one year prior to this examination, resulted in marked swelling of the knee during the first twelve hours following the injury, but this was not associated with locking. This swelling subsided with rest after a few days, but there have been intermittent recurrences of similar swelling following slight twists or excessive strain during the year preceding this examination. Pain and tenderness have always been localized over the medial aspect of the knee joint.

examination usually rules out the presence of an injury or a loose body and so, these two conditions, which mimic each other so often, may be differentiated. Having excluded the presence of a ruptured meniscus and having demonstrated the presence of a loose body, the roentgen examination alone is responsible for an accurate differential diagnosis in this large group of derangements of the knee joint caused by loose bodies.

SPRAIN OR RUPTURE OF THE TIBIAL COLLATERAL LIGAMENT

The tibial collateral ligament is a broad flat membranous band situated nearer to the back than to the front of the joint. Its attachments extend from the abductor

FIG. 8. Organized ossifying periostitis around injured upper attachment of the tibial collateral ligament. The meniscus could be demonstrated, indicating absence of excessive synovial fluid. This knee had been injured seven years prior to this examination in a football accident which caused immediate swelling, limitation of motion, pain and tenderness, especially over the inner aspect of the knee joint. No locking occurred. Since the initial injury, there have been recurrent episodes of giving way of the knee joint followed by transient swelling.

tubercle above to the tibial tuberosity below. The posterior oblique fibers are short, inserting into a groove of the tibia above the semimembranosus. The anterior portion is flat, about 4 inches long, inclining slightly forward as it descends. The internal meniscus is not bound down to the tibial collateral ligament as usually described in textbooks of anatomy. There is usually a loose attachment between the anterior portion of the ligament and the meniscus, often with an interposed bursa, such as is normally present in apes. Only the posterior portion of the ligament is firmly attached to the peripheral border of the internal meniscus.

If excessive rotation of the femur occurs, especially during flexion when excessive abduction of the leg is more readily produced, tears of the ligaments are more apt to occur, which often takes place in conjunction with injuries or ruptures of the menisci. Sprain or rupture of the tibial collateral ligament causes pain and tenderness on the inner side of the joint over the attachments of the ligament. The short posterior or oblique portion of the ligament is likely to be sprained when there has been injury to the internal meniscus. If signs of an injured internal cartilage fail to develop, a ruptured tibial collateral ligament may be diagnosed by the persistence of swelling, pain and tenderness on the inner aspect of the knee. Recurrences are not infrequent when the original injury has been inadequately treated. A minor twist or turn is sufficient to bring on a recurrence, causing a sudden "giving way" of the joint followed by swelling, and a chronic condition may then supervene with the evolution of a chronic arthritis. Additional symptoms may become evident such as increasing abduction of the leg and thickening of the tibial collateral ligament due to fibrosis or ossifying periostitis. In severe injuries,

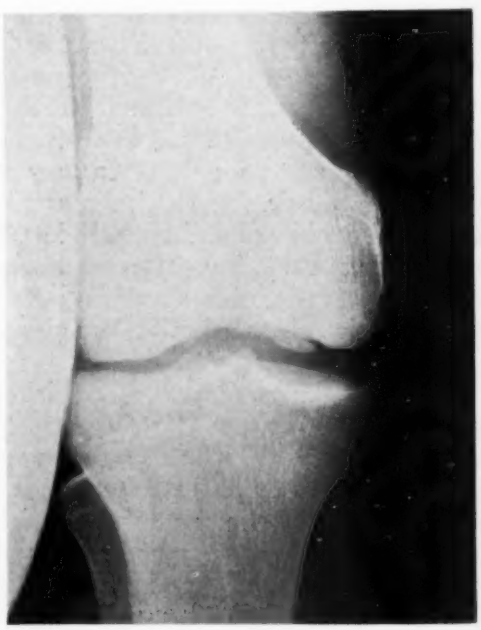

FIG. 9. Osteochondritis dissecans with slight thickening of the synovia. The meniscus could not be demonstrated.

there may be an avulsion of the periosteum where the ligament is attached to the bone. This occurs more frequently from the femoral than from the tibial attachment and when this condition heals, it resembles Pellegrini-Stieda's disease.

The roentgen findings in the acute phases of injury to the tibial collateral ligament include visualization of soft tissue swelling around the knee, more marked on the inner aspect. Swelling caused by contusion and edema is slight, but swelling caused by hemorrhage is apt to be marked. Synovitis is usually present with ligamentous injuries and the slightly increased synovial fluid which is present precludes demonstration of the meniscus. Definite swelling or thickening of the injured portion of the tibial collateral ligament can be demonstrated more easily by comparison with the opposite knee in the roentgenograms. This is best seen in the anteroposterior and oblique views. In the chronic phase of sprain or rupture, fibrous thickening of the ligament may be visualized, sometimes with adjacent fibrosis in the perifocal overlying subcutaneous tissues. Rarely is ossifying periostitis present in the region of the ligamentous insertions.

Fig. 10. Longitudinal patellar view of osteochondritis dissecans (same case as in Fig. 9).

Fig. 11. Bilateral synovial chondromas with thickened synovia in a patient whose knees give way intermittently without locking.

PERI-ARTICULAR BURSITIS

The many bursae about the knee are not demonstrable normally by roentgen examination, but they may be seen when they fill with fluid as the result of bursitis. Slight swelling of the suprapatellar bursa, and the synovia with which it is continuous, is easily detected roentgenographically. This bursa is quite distensible and it can contain a surprisingly large amount of fluid. The prepatellar bursa is readily visualized when it contains only minimal amounts of fluid. The clinician is sometimes unable to exclude a co-existing synovitis in the presence of a prepatellar bursitis, but by the use of the technique to demonstrate the meniscus and by examination of the suprapatellar bursa and the patellar fat pad, the roentgenologist can easily furnish the correct information. Swelling of the pretibial bursa, not infrequently found with Osgood-Schlatter's disease, is nicely delimited by roentgen examination. Cysts of the posterior bursae or synovial membrane may be visualized if careful inspection of the soft tissue outlines is made routinely. These cysts may arise from any bursae, but they are generally encountered in the posterolateral aspect of the knee. With extension and flexion of the knee, these cysts may change in size

and shape, being directly connected with the synovial space. Lateral examination of the knee in flexion and extension may confirm these clinical findings, an important consideration to the surgeon called upon to treat the case.

Fig. 12. Hypertrophy of the inner alar fat pad. The demonstration of the internal meniscus confirms extracapsular limitation of condition.

CYSTS OF THE MENISCI

Cysts of the menisci, particularly of the external meniscus, is a well recognized condition. They are hemispherical masses attached to the periphery of the meniscus and they are comprised of a series of well defined spaces filled with a thick transparent mucoid material. Bristow found in them no evidence of inflammation or hemorrhage and believed that trauma plays no part in their causation. He concluded that they represent degenerative cysts comparable to ganglia, arising in the synovial and extrasynovial fatty and areolar tissue as well as in the fibrocartilage. Fisher believed that the external meniscus is usually involved because it is the only cartilage that normally receives a partial covering of synovial membrane where it is crossed by the popliteus tendon; and it is at this crossing where these cysts are found. He ascribed direct or indirect trauma as their cause through strain exercised by the popliteus tendon.

The local swelling and pain caused by these cysts can be detected clinically, but careful study of the soft tissue shadows by the roentgenologist leads to a more accurate diagnosis. The demonstration of the meniscus in these cases rules out the presence of a torn or displaced meniscus, which is not done with ease clinically.

Fig. 13. Cyst of the external meniscus.

NEOPLASMS

The malignant nature of bone tumors can be determined not only by searching the cortex and periosteum for evidence of a break-through into the adjacent soft tissues, but also by assiduous inspection of the soft tissue outlines for signs of invasion. Tumors arising in the soft structures, like xanthomas, angiomas and fibrolipomas, are

easily overlooked unless routine scrutiny of the soft tissues is a confirmed procedure.

MISCELLANEOUS CONDITIONS OF THE SOFT TISSUE

Varicosities of the popliteal and long saphenous veins and of some of their branches can be seen in roentgenograms without difficulty. Contusions with extracapsular edema or hemorrhage can be distinguished from intracapsular swellings and confirmed by the demonstration of the meniscus. Conversely, traumatic synovitis can be separated from contusion or other extracapsular swellings, and confirmed, by failure to demonstrate the meniscus because of the presence of excess synovial fluid. This differentiation between intra- and extracapsular causes of knee swellings by the roentgen examination can be a source of much satisfaction to both the clinician and roentgenologist.

SUMMARY

1. The technique for the examination of the menisci is discussed.

2. The value of the roentgen study of the soft tissues of the knee in conjunction with examination of the menisci is stressed in achieving accurate diagnoses of derangements of the knee joint.

3. A review is made of conditions which simulate internal derangements of the knee joint, and the roentgen appearances of the menisci and soft tissues in each of these conditions are described.*

* For discussion see page 354.

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POST-TRAUMATIC PARA-ARTICULAR CALCIFICATIONS AND OSSIFICATIONS OF THE ANKLE

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POST-TRAUMATIC calcifications and ossifications about the joints are a problem of prime importance and are frequently encountered in military personnel due to the rigorous physical training program. Several types of post-traumatic deposits have been described, indicating the multiplicity of the roentgenographic appearances. Ossifying myositis, myositis ossificans progressiva, avulsion sprain fracture and peritendinitis calcarea are some of the names applied. The entity in the knee has been thoroughly described by many authors.[13,16,17,25] Little has been said in published literature regarding these new formations in the region about the ankle following trauma, yet this area suffers as many injuries as does the knee. Lewin[19] in his recent textbook on "The Foot and Ankle" makes only slight reference to this particular condition. I have recently seen several cases of post-traumatic para-articular involvement of the ankle joint and the marked similarity of the roentgenographic findings at the site of the ankle to this syndrome of the knee merits a review of the etiological factors and pathology of post-traumatic calcifications and ossifications advanced by the various authorities.

Pellegrini[21] in 1905 and Stieda[24] in 1907 originally described the syndrome in the knee, with the former stating that dual processes of periosteal proliferation and direct metaplasia of ligamentous structures existed, while the latter contended that it was the result of a periosteal stripping from the femur. An editorial[5a] in this JOURNAL in 1932 was apparently the first mention in English literature of Pellegrini-Stieda's disease, or post-traumatic calcification of the collateral tibial ligament, and Kulowski[16] in 1933 published an article on the subject. Later, in 1942, he[17] presented a graphic and comprehensive dissertation on the same subject with the conclusion of the paraosteal origin of the new growth.

Köhler[15] expresses the opinion that the bony shadows may be due to ossification of connective tissue; however, a tear of the periosteum may occur. Usually no defect in the bones can be observed. Some observers[7,9,11] feel that organization of a hematoma in the connective tissue after rupture of small blood vessels may account for the lesion. One cannot eliminate the fact that formation of bone may occur on a connective tissue basis. Ferguson[8] makes the statement that trauma may cause stagnation of fluid in the muscle or fibrous tissue with a resulting calcification. The deposits may be somewhat diffuse and amorphous, later becoming more dense, sharply defined and contracted. If resorption occurs, the deposit loses its density and disappears. If resorption does not occur and is subject to strain and stress, osseous formation may result. The tendency to calcification of stagnant fluid, blood or lymph in muscular tissue is confined usually to the muscle involved, with an axial distribution and a fanning out in the direction of the muscle fibers.

The separation of a flake of bone from the surface was suggested by Brailsford[3] as the cause of the deposits visualized three to four weeks after the injury. He remarks that one can note a linear shadow on the external malleolus of the fibula which suggests a thin scale of bone, but this is probably ossification of a damaged ligament.

* Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

Two authors, Geschickter and Copeland,[11] definitely state that, histogenetically, the source of new bone is fibrous strands in the muscle, or tags of precartilaginous connective tissue of embryonic origin which is displaced from the primitive periosteum. A hematoma may be the important antecedent to the ossification. Dean Lewis has been quoted as stating that stripping of the periosteum due to injury is the source of the new bone which is formed at this site. These authors maintain that this would account for some types, but not for the myositis ossificans derived from cartilage. The mottled appearance of the calcification extending into the muscle seems to disprove that periosteum to any degree has been displaced for the reason that as a limiting membrane of ossification it tends to produce a rather circumscribed bone lesion. Their opinion is that injured vessels supplying the area traumatized may account for the increased calcified deposition with a chemical background stimulating bone formation.

That bone formation of a heteroplastic character may begin as a course either of cartilage or fibrous matrix is well recognized. The vascular increase in the cartilage with ossification about the small vessels indicates osteoblastic activity. The strands of connective tissue attempt to become hyaline with osteoblasts influencing calcification of the osteoid tissue, later followed by true bone. The process is one of metaplasia, and fibroblasts assume the function of osteoblasts. Finder,[9] in 1937, presented excellent microscopic evidence of the formation of heterotropic bone and quotes the work of Freund[10] and his theory of mechanical irritation of tissue by edema causing calcification and osseous formation. Epstein[6] and his co-workers found metaplastic bone formation in advanced calcification.

Ewing[7] believes that several conditions may influence the osteoblastic tendencies in fibroblasts: (*a*) the new bone formation results from osteoblasts wandering away from the periosteum; (*b*) calcified deposits occur frequently in ossification of necrotic tissue; (*c*) actively productive inflammation with organization of dead tissue and hemorrhage is essential in the ossification of muscle tissue after trauma; (*d*) there may be special predisposition to calcification and ossification, possibly related to the disturbance of calcium metabolism.

The concepts set forth by Barr[1] regarding all phases of abnormal calcification have been emphasized by Ghormley,[12] and give the following as local causes contributing to the deposition of calcium: (*a*) fatty degeneration; (*b*) formation of phosphoric acid in the tissue; (*c*) combination of protein with calcium (not proved); (*d*) alkalinity of dead and dying tissue. Barr further adds that calcified deposits are probably not composed of a single substance. Burge[4] and his associates advanced the hypothesis that active injured and dying tissues are electronegative to inactive and uninjured sound tissues. They showed experimentally that injury renders tissue electronegative to the uninjured portion and that calcification may result from the combination of positively charged calcium ions of the blood with negatively charged phosphate ions of the injured tissue.

Klotz[14] demonstrated the essential mechanism of calcium deposition which is always preceded or accompanied by the formation of soaps in the degenerating tissue, to which calcium is immediately attracted from the body fluids. Hitchcock[13] stated that these soaps may be found in the peripheral zone of the calcareous infiltration while calcium is still being laid down, even when the process is extensive. Replacement of the fatty acid by the stronger phosphoric and carbonic acids rapidly ensues, giving rise to the more stabile calcium phosphates and carbonates of which these deposits are largely comprised. Hitchcock described calcium deposits about the various joints initiated by trauma and vaguely mentioned the ankle as one location where this may occur. The consensus of many workers is that calcium deposition in these related conditions does not mean a disturbance of generalized calcium metabolism.

A brief survey of the anatomy of the ankle as a hinged joint is in order. The talus, the tibia and the fibula are the bony components of this joint. The distal ends of the tibia and fibula are strongly bound to each other by the interosseous ligament which fades upward into the interosseous membrane. The anterior and posterior malleolar ligaments and the inferior transverse ligament assist in the syndesmosis. The thin ligamentous articular capsule surrounds the joint and is attached above to the articular margins of the malleoli and the tibia and below to the articular margin of the talus. The deltoid ligament on the mesial aspect and the external lateral ligament (the anterior and posterior talofibular and calcaneofibular ligaments) on the outer aspect flank the joint on these surfaces. The tendons of the tibialis posterior, flexor digitorum longus and the flexor hallucis longus support and reinforce the ankle joint posteriorly. These are encompassed in mucous sheaths and bound down by the ligamentum laciniatum. The posterior tibial vessels and the tibial nerve also pass beneath this fibrous band which extends from the tibial malleolus to the margin of the calcaneus. The strong tendo achillis, arising from the gastrocnemius and soleus muscles, is attached to the posterior surface of the calcaneus with an interposed bursa between the tendon and the bone. Areolar and adipose tissue fills the space between the Achilles tendon and the structures on the posterior aspect of the tibia. This zone, roentgenographically, has been named by us the *supracalcaneal triangle* for lack of a better term, with the boundaries, the anterior border of the tendo achillis, the posterior aspect of the tibia and the contiguous soft tissue, and the base, the posterosuperior surface of the calcaneus. Superficially, it is marked by prominent lateral depressions just above the heel. Anteriorly, the transverse crural ligament binds down the mucous sheathed tendons of the extensor digitorum longus, extensor hallucis longus, peroneus tertius, tibialis anterior and the anterior tibial vessels and deep peroneal nerve. Another ligament, the cruciate, can be found just below the transverse crural also enveloping these tendons on the anterior aspect of the ankle. The peroneal retinacula (external annular ligament) embraces and fastens down the tendons of the peroneus longus and brevis laterally. The prominent malleoli are readily observed and can be palpated. Between the medial malleolus and the anterior tibial muscle, a small indentation in the soft tissue can often be seen with a similar concavity between the lateral malleolus and the peroneus tertius. These depressions indicate the level of the ankle joint. When intra-articular pathologic involvement exists, they are smoothed or bulged out.

Trauma is the predisposing factor for the production of para-articular calcification and is elicited in the history. The individual may have suffered a minor injury such as a sprain several weeks before, or a severe wrench may have occurred which at that time suggested the possibility of a fracture. Pain of considerable intensity persists long after the injury and initial treatment, and varies from a dull throb to one of lancinating character. The patient complains that walking causes discomfort even to the point of inability to bear weight. Usually some edema and soft tissue thickening are present. There is a definite restriction of motion and an aggravation of the pain on manipulation of the joint. Localized tenderness exists behind the malleoli with some obliteration of the lateral depressions anterior to the Achilles tendon. The soft tissue swelling is of the indurative type with but little pitting possible. No mass or calcified tumor is palpable. With such a picture, one should then suspect the possibility of para-articular calcification or ossification.

The absolute diagnosis of this para-articular syndrome can only be made by serial roentgen studies. At the time of the injury, the roentgenogram usually reveals no osseus involvement, with only soft tissue thickening and infiltration about the joint. The triangular dark shadow described above the os calcis posteriorly and

called the supracalcaneal triangle can be encroached upon or obliterated as the result of hemorrhage or exudate which may be intracapsular or extracapsular, or both. Subsequent roentgenograms after an interval of three to four weeks will show the deposits of calcium. These can be found paralleling the surface of the posterior malleolus of the tibia, the superior anterior aspect of the talus, or along the lateral margin of the fibular malleolus, with a definite clear space between the calcification and the bone, indicating the para-osteal origin of the formation. Calcified particles are often seen between the fibula and tibia and laid down in the interosseous membrane. The appearance of the calcifications is variable with a prevalence of the crescent shape of the deposit opposite the posterior lip of the distal end of the tibia. Many are linear at other sites. Calcification in a hematoma is usually of rather diffuse appearance with the deposits irregular and amorphous and confined to the mass density of the hematoma. The formations of calcium initially are amorphous which may ossify with trabecular structure permeating the new growth. In this respect alone can calcification be differentiated roentgenographically from ossification. Later studies may reveal a fusion between the ossified density and the adjacent bone. At this stage, the similarity to a traumatic arthritis or a healed avulsion sprain fracture is indistinguishable.

The classification by Petrignani[22] for the knee of the two main types of para-articular involvement can well be applied to the ankle and depends upon the stage of development as to the type: (*a*) the evolutive; (*b*) the stabilized. The former type of involvement appears fuzzy and has hazy margins with different degrees of opacification in the adjacent connective tissue. The stabilized type is a mature, contracted and well defined density.

Fig. 1. The bony structures appear normal. No fracture can be seen. Clouding of the joint posteriorly exists with encroachment on the supracalcaneal triangle.

The series of cases observed at this station hospital are 4 in number and present similar findings clinically and roentgenographically. A single case report is submitted.

CASE REPORT

The patient, a white soldier, aged twenty-two, on January 12, 1944, was wrestling with another soldier and twisted his right ankle. At this time, he experienced considerable pain with swelling of the ankle soon following. He had difficulty in walking, with limited mobility of the

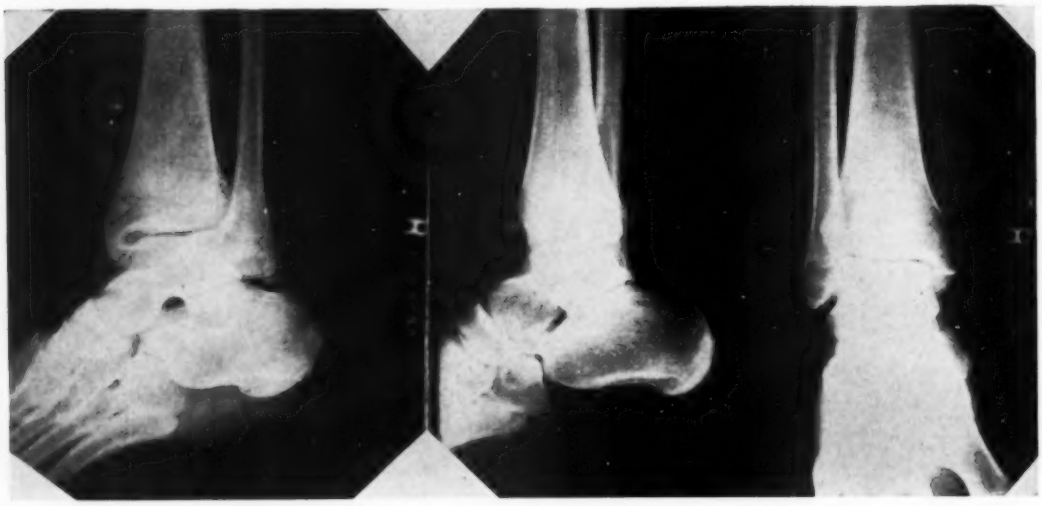

FIG. 2. Calcified deposits of film-like appearance are seen laid down in the interosseus membrane. A large crescent-shaped calcification is noted opposite the posterior margin of the tibia just above the distal articular surface. A clear space exists between the tibia and this shell-like formation.

ankle joint necessitating limping. On reporting to the Infirmary, he was immediately sent to the Roentgen Department for examination. The roentgenogram "revealed no osseous involvement; however, the joint space showed clouding and distention indicative of a synovial condition of probable traumatic origin" (Fig. 1). Due to the clinical manifestations and the inability of the patient to carry on his duties, he was hospitalized for nine days. His treatment consisted of ice packs, bed rest with elevation of the extremity and mild oral analgesic medication. After this interval, he was sent back to duty. When he left the hospital his ankle still showed slight persistent soft tissue thickening with tenderness slightly posterior to the malleoli. Pain was still present although slight and the patient had a limp.

He attempted to carry out full duties but the discomfort in the ankle continued. Several times he came to the Infirmary to have his ankle strapped and then returned to duty. As the

FIG. 3. The density on the posterior aspect of the lower tibia now has a bony character and is fused to the tibia. The calcified deposits in the interosseus membrane are unchanged.

result of his poor response to this therapy, a recheck roentgenogram was taken on February 23, 1944. The roentgen report indicated "a linear film-like calcification between the fibula and the tibia apparently in the interosseous membrane. The deposits seemed to fade into the periosteum of the tibia about 3 inches above the ankle mortice. A crescent-shaped calcification along the posterior malleolus of the tibia could be seen and was not attached to the bone" (Fig. 2).

The soldier was then recommended for less arduous duty and physiotherapy was initiated. His symptoms improved within a period of two to three weeks with an abatement of the pain, and he carried out minor duties (clerical) successfully. Another roentgenogram was taken on May 10, 1944, which showed "the posterior deposit now to be of bony character and fused to the tibia. The interosseous calcified deposits remained the same" (Fig. 3). Clinically, the full range of motion of the joint had not returned; there was a limitation of eversion and dorsiflexion, and slight discomfort was still noted.

TREATMENT AND PROGNOSIS

The more conservative measures of immobilization and physiotherapy are logically the methods of choice. In the individual having moderately severe symptoms, bed rest with elevation of the extremity slightly above the level of the hip, and ice packs applied locally acting as mild anesthesia, tend to control the pain and discomfort. Salicylates with small doses of codeine may occasionally be needed. The milder cases are sent back to limited duty with a desk job prescribed as well as a request that the patient be exempt from physical training, marching formations, and duties requiring standing for any length of time. Diathermy is administered frequently with considerable amelioration of the physical symptoms.

If pain persists in the joint after conservative therapy, additional measures may be required. Injection of an anesthetic into the joint can be carried out as the results obtained by Leriche[18] in sprained ankles are unusually good following injection of an anesthetic into the traumatized tissues on the basis of his conception of sprain as an injury of the intraligamentous nervous system. His contention is that pain is due to contractures and that early injection into the periarticular structures is necessary. Unquestionably, there is a definite therapeutic value in this procedure but one must not forget the fact that some danger is connected with this method and an infection can be incurred.

Several men[16,17,23] have attempted surgical treatment of the condition in the knee which has been followed by a recurrence of the calcification. They strongly advocate allowing the lesion to become stabile before any surgical intervention is instituted. This seems reasonable in view of the similarity to myositis ossificans.

Radiation therapy has been used by Bellucci[2] with favorable results in respect to involvement of the knee. Other investigators are more conservative in acknowledging the use of irradiation in conditions similar to this one. Its use would seem most advisable in recent lesions of the evolutive type. The more mature calcification would tend to show less regression and dissolution of the deposits. Probably pain and muscle spasm may be influenced and benefited by irradiation based on the theories offered and discussed by Desjardins.[5] While we have not the therapy equipment at our hospital to adequately and properly irradiate these cases, irradiation undeniably has merit in conservative therapy.

The prognosis of disability of the ankle joint depends on the type and extent of the injury. In this condition, our cases have shown a partial disability of fairly long duration with a limitation of the functional capacity of the individual. An average of 15 per cent restriction of motion exists over a period of several months. The pain usually lessens during this time; whether this is due to improvement in the condition or an elevation of the pain threshold in the individual cannot be definitely ascertained. It is likely that the maturity of the lesion as well as disappearance of the edema about the ankle contributes to the diminution of

the pain factor. Full function is not entirely regained, and some clinical manifestation of disability remains. The calcifications persist and undergo either individual maturity or fusion. Spontaneous regression may occur but this has not as yet been seen in any of our cases.

I wish to thank Captain I.C. Winter, Captain J. J. Haggerty and Captain W. G. Hansen for their cooperation and suggestions in the preparation of this paper. The Army Air Forces Training Command deserves credit for the prints of the illustrations.

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DISCUSSION OF PAPERS BY DRS. LEWIS, GERSHON-COHEN, AND PIATT

Dr. Lawrence Reynolds, Detroit, Michigan. I wish to compliment Dr. Gershon-Cohen for a splendid presentation of an important subject. Since 1937 we have been making this type of examination both at our office and at Harper Hospital, and we have examined a number of cases. Over one hundred cases have been operated upon as a result of this type of examination and in two of those cases we had missed the lesion.

The technique is an excellent one for the examination of injuries to the knee joint in that it is not a difficult one, but it does require a very special, meticulous care in the examination of these patients. As Dr. Gershon-Cohen does, we examine both knees in the anteroposterior projection and also in the lateral projection, with particular attention to the soft tissue detail, which he has so nicely shown in his roentgenograms. We examine these three films before we "stretch the knee" because we want to be sure there is no contraindication to the stretching of the knee joint. Our method of examination is essentially the same as Dr. Gershon-Cohen's. Our roentgenograms at the time of stretching the knee are made either in the anteroposterior or the posteroanterior projection.

We also have had two or three cases where there appeared to be a slight regeneration of the cartilage after it had been removed, but

appearances similar to regeneration will be shown on the roentgenogram taken during the stretching of the knee joint.

We have found that in cases where there was injury to the cartilage, there is a small amount of sclerosis along the margin of the internal tibial tuberosity. This may be very slight and requires careful examination. If a magnifying glass is used in the study of the anteroposterior view, a slight sclerosis will be seen which gives some clue and that and a very small amount of effusion in the suprapatellar bursa of the injured knee, as well as an inability to demonstrate the internal semilunar cartilage, are the criteria for making the diagnosis. We try to be very careful in this sort of examination because unless the technique is carried out properly, one may be misled in the interpretation of the roentgenograms.

We have not been able to show the external semilunar cartilage with any degree of satisfaction and I am pleased to know that Dr. Gershon-Cohen has been able to show it in about 20 per cent of his cases.

Of course we never use this type of examination in acutely injured knees. It is used in those cases in which the patient gives a long history of disturbance in the knee joint. However, with this method of examination I think one can demonstrate very definitely whether or not there is a derangement of the cartilage.

Dr. Ralph S. Bromer, Bryn Mawr, Penna. Captain Piatt is to be commended for bringing to the attention of roentgenologists this lesion of the ankle joint. He mentioned two types of the lesion, the evolutive and the later type in which the fuzzy, variegated appearance of the calcification changes to a stabilized type which is a well defined, sharply outlined, calcified shadow. Pellegrini, in describing the lesion in the knee joint, attempted to go somewhat further and explain the characteristics of the lesion according to the nature of the injury. Thus, those secondary to sprain were small and presented regular margins, while those secondary to or around a hematoma were more squat and globular and sometimes irregular in outline. He also stated that in the knee joint when the lesion occurred after attempts at mobilizing a partially ankylosed joint the calcified areas were quite large, voluminous and irregular. After sprains of the knee joint the lesion was often longitudinal, after contusion it was often transverse, and after both sprain and contusion combined it was expansile in both directions. I think it will be interesting to note whether such distinctions can be made in the ankle joint.

The medicolegal aspect of this lesion is important and, again to quote Pellegrini, his rules for indemnification of cases in Italy may be useful. He stated that (1) no indemnity should be granted in cases where ossifications are slight and when no atrophy of the joint or any other joint changes are present; (2) minimal indemnity could be granted when atrophy or joint changes are slight or when the lesions are conspicuous in the roentgenogram; (3) when functional limitation is severe, indemnity should be higher but emphasis must be laid on the fact that only a small part of the disability is usually due to the ossifications themselves.

In regard to the case shown by Captain Piatt it would seem that the location and its close relation to the interosseous membrane would be an argument in favor of the periosteal tear theory in the production of the lesion.

Dr. Lewis is to be commended for drawing our attention again to the work of Phemister on the differential diagnosis of pyogenic and tuberculous arthritis. There is one point that is worthy of mention in regard to the long preservation of the joint space in tuberculous arthritis. If, in cases of pyogenic arthritis, the infection begins in an extra-articular location near the capsule of the joint, the joint cleft may be preserved until the infection finally ruptures into the joint. This may be confusing in that at first it may resemble the picture of a tuberculous arthritis. Once the rupture has occurred the cleft disappears as described by Dr. Lewis in pyogenic infection.

Dr. Ross Golden, New York. I have long been an admirer of Dr. Lewis' skill in the interpretation of soft tissue shadows about joints, particularly about the knee. It seems to me that we have not yet devised the best technique for the knee joint shadows. If we use a technique which shows the soft tissues, we are likely not to get the detail of the center of the bone. On the other hand, if we show the center of the bone, we are likely to obliterate the soft tissues. We have been trying in some cases the taking of roentgenograms with a heavy filter, 0.1 mm. of copper, using about 75 kv. If one is careful not to overexpose, one can get bone structure and can show, in some cases beautifully, the soft tissue structure, the tendons, etc., around the knee joint.

I do not think that is as yet the ideal technique. Possibly a combination of exposures on the same immobilized joint, using a heavy filter and then taking the filter out for perhaps 10 to 25 per cent of the exposure and using an unfiltered beam, would be still better. We need to do a little more experimenting with technique to show the knee better.

I have also been admiring Dr. Gershon-Cohen's work with these meniscus and other knee injuries, and I would like to ask him whether he believes we should use that tangential view of the patella in all cases of routine examination of the knee, or whether he feels it is necessary only in the injured cases.

Dr. Gershon-Cohen (closing). I wish to thank Dr. Reynolds and Dr. Golden for their very kind remarks.

Any technique that can be used to bring out the various soft structures, such as the method advocated by Dr. Golden, is highly desirable; but I think that, finally, more can be accomplished by making regular exposures without special techniques for different tissues and resorting instead to the use of special viewing apparatus for obtaining all the information the roentgenogram has to offer.

So far as the tangential view of the patella is concerned, I suppose the question resolves itself into one of economics and individual preference. If each patient could be examined clinically by the roentgenologist, perhaps it might be possible to exclude those cases in which this view could be omitted. Nevertheless, if the tangential view of the patella is not taken routinely, it is surprising how much valuable diagnostic information is lost.

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TRANSITIONAL EPITHELIAL CELL CARCINOMA OF THE NASOPHARYNX*

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MEMPHIS, TENNESSEE

ATTENTION is usually directed to the nasopharynx by angina, epistaxis, dysphonia, dysphagia, nasal or pharyngeal obstruction and cervical adenopathy. Such attention is not usually given this region when the presenting symptoms are a slight alteration in hearing, tinnitus, pain in the maxilla or mandible and symptoms referable to the various cranial nerves. That these latter signs and symptoms should indicate a most painstaking search of the nasopharynx for malignant lesions is not a matter of common knowledge, in spite of numerous expositions on the subject in the last thirty years.

Nasopharyngeal tumors have been given careful consideration by otolaryngologists, roentgenologists, and pathologists, yet, unfortunately, there are very few patients whose pathological condition is diagnosed before an advanced stage is reached.

Transitional epithelial cell carcinoma has been, in our experience, the most common variety of tumor found in the nasopharynx. It comprises over two-thirds of the nasopharyngeal growths observed in the Department of Radiology of the Baptist Memorial Hospital. The tumor is an unusually cellular growth, which invades and infiltrates surrounding structures and metastasizes rapidly. It is composed of extremely undifferentiated, anaplastic cells and its clinical course is very characteristic, usually rapidly fatal.

Tumors, other than transitional cell, have been excluded from this study; all cases have exhibited typical clinical symptoms and the reports of the biopsies have been positive.

These tumors are considered to be rare, yet 16 have been observed and treated in a period of five years, from July, 1937, to July, 1942; also, at least sixty articles on the subject appear in the literature, some containing large series of case reports.

HISTORICAL

In 1903 Krompecher[10] described an undifferentiated tumor of the nasopharynx which he believed arose from the basal cell layer of the mucosa and named it basilioma. However, Trotter[22] was the first to point out the unusual clinical features of this disease in 1911. In his description of "Certain clinically obscure malignant tumors of the nasopharyngeal wall," he noted "the unusual difficulty in making this diagnosis," and the very important point that "diagnosis is entirely dependent upon the recognition of symptoms of infiltration of the nasopharyngeal wall, extension into the cranial cavity, involvement of the eustachian tube and early metastases to the glands of the neck."

In 1921 Reverchon and Coutard[18] reported from Regaud's Clinic a tumor which was highly radiosensitive and composed of anaplastic cells of epithelial origin intermixed in a syncytium with varied numbers of leukocytes. Because they believed that these cells arose from cells located around lymphoid tissue deposits in the pharynx and nasopharynx which resembled both epithelium and lymphoid cells, they called it lymphoepithelioma. In the same year Schmincke[20] described a tumor which differed slightly from the Regaud type in that the principal cells were scattered diffusely in a loose reticulum.

In 1921 Jacod[9] recognized the growth and wrote of it as "peritubular sarcoma." He believed that the intracranial extension took place by way of the bony part of the eustachian tube but was directed forward into the middle fossa by the denseness of the petrous bone.

* From the Department of Radiology, Baptist Memorial Hospital, Memphis, Tennessee.

In 1931 New[15] of the Mayo Clinic brought to the attention of American otolaryngologists the syndrome of malignant tumors in the nasopharynx.

Woltmann[24] analyzed the neurological findings in New's cases and isolated case reports collected from the literature the same year. In 1923 Crowe and Baylor[3] described the findings and results of surgical and radium therapy on a large number of cases of "sarcoma and carcinoma" of the nasopharynx, many of which would now be considered transitional cell carcinoma.

The term transitional cell epidermoid carcinoma was introduced by Quick and Cutler[17] in 1927. They were impressed by the lack of usual squamous cell features in the carcinomas and their high radiosensitivity. Hayes Martin[13] has written extensively on the therapeutic aspects of the disease.

PATHOLOGY

This neoplasm usually begins in the nasopharynx in or near the fossa of Rosenmüller, in the vault around the pharyngeal tonsils, on the lateral wall, the palatine tonsils, the lingual tonsils, the base of the tongue and rarely the hypopharynx. There have been cases described that were found in the ethmoid and maxillary sinuses, but it is questionable whether this was the primary focus. Secondary foci have been described by Gardham due to contact of polypoid nasopharyngeal growths.

Trotter divided his cases into two types: (1) those that were polypoid and extended into the nasopharynx, sometimes to such a degree as to obstruct the nares, displace the soft palate and produce symptoms of pharyngeal obstruction; (2) those in which this polypoid development was absent.

The second class of tumor is more common and much more difficult to diagnose. When observed in the nasopharynx the tumor is commonly small and may present only a slight flat nodule in the region of the eustachian tube or fossa of Rosenmüller. It may be slightly pink in color and appreciable only as a perceptible hardening in the wall of the pharynx. There may be slight ulceration, and if ulceration is present a yellowish mucoid membrane may obscure it. *A curious characteristic of the growth is its tendency to spread widely beneath the mucous membrane without causing ulceration.* This has been emphasized by Cappell[2] in his study of lymphoepithelioma. The neoplasm burrows beneath the mucous membrane invading the deeper tissues of the pharynx and extending through the basal foramina into the middle fossa of the skull. The muscles of the neck and face may also be infiltrated. The eustachian tube, quite early, may be compressed or completely blocked. Cases of mastoid destruction by extension through the eustachian tube have been described. Metastasis to the lymph nodes of the neck is a very early and common feature. Distant metastases often occur in the late stages of the disease.

The process usually extends into the skull by way of the floor of the middle fossa. It is probably prevented from extending dorsally into the cervical vertebrae and soft tissue by the dense pharyngeal aponeurosis. This structure may tend to direct it upward into the sphenoid and temporal bone. Most writers have believed that invasion of the cranium takes place through the basal foramina. Martin and Blady[14] indict the foramen lacerum and Jacod the eustachian canal and the petrotemporal suture. Some of our patients exhibited so much erosion of the greater sphenoid wing that it seemed probable that the invasion took place by invasion and infiltration of the bone itself. In some instances the foramina could be clearly defined in an area of partial destruction.

A recent autopsy, reported by Bach, Lederer and Palevsky,[1] included a description of the route of invasion. There was destruction of the petro-occipital suture, the foramen lacerum, the greater sphenoidal wing and the tip of the petrous pyramid. They believed the tumor grew by eroding and replacing the bone, having a special affinity for the marrow spaces.

Once in the cranial cavity, it burrows beneath the dura but seldom breaks through. It may extend along the cavernous sinus, destroy the clinoids and invade the orbit through the superior orbital fissure. It rarely enters the posterior fossa yet the petrous apex is often eroded and one of our cases showed destruction around the jugular foramen.

It is quite probable that most cranial nerve involvement occurs in the cavernous sinus and not necessarily in the basal foramina.* This is particularly true of the third, fourth, ophthalmic branch of the fifth, and the sixth nerves, since they course through the cavernous sinus to emerge through the superior orbital fissure and not through the floor of the middle fossa. Involvement of the abducens nerve, a common complication, would, then, usually indicate invasion of the cavernous sinus.

Involvement of practically all the cranial nerves has been reported. Those most commonly affected are the fifth, sixth, third and fourth as shown by reports in the literature. Involvement is progressively less on either side of these four nerves, in ascending or descending order.

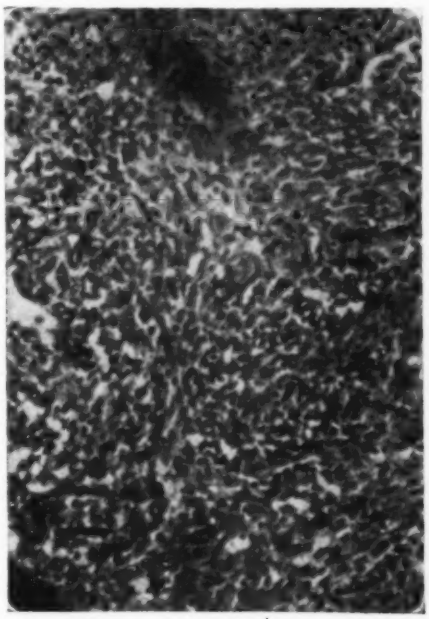

Fig. 1. Low power photomicrograph of typical section of transitional epithelial cell carcinoma.

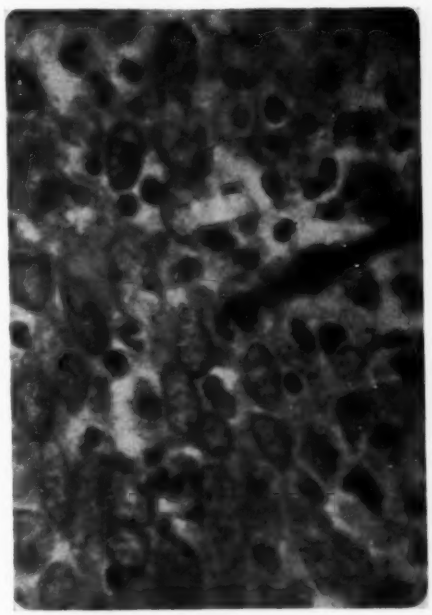

Fig. 2. High power magnification of same section.

MICROSCOPIC PATHOLOGY

It is not our intention to enter into a discussion of the cellular pathology and identification of the cell origin. There is considerable confusion in the literature and disagreement among pathologists as to the nomenclature and biologic nature of these tumors. Regaud, Schmincke, Cappell, and others, have described these lesions under the term lymphoepithelioma. Although some pathologists attempt to differentiate the Regaud, Schmincke and Ewing types, in America it has been the custom to group them under the term advanced by Quick and Cutler, and Ewing of "transitional epithelial cell carcinoma.

Salinger and Perelman[19] in an effort to simplify the nomenclature submitted a group of microscopic slides to three pathologists. Although there was a certain uniformity of opinion, some of the same sections were classified under lymphoepithelioma, transitional cell carcinoma and anaplastic epidermoid carcinoma. Thus, the exact terminology is often modified by personal opinion and experience.

* An article by Lenz[11] emphasizes this point.

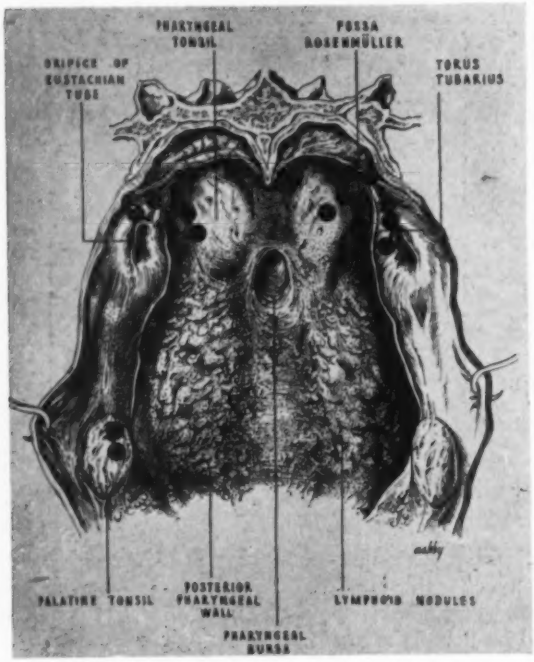

Fig. 3. Locations of pimary lesions in 15 cases.

Ewing[4,5,6] has pointed out the extreme difficulty in making a clear distinction between the anaplastic growths of this region. A recent careful study by Frank, Lev and Blahd[7] compares the different types of cells and, despite balanced objections, retains the term transitional cell carcinoma.

The fundamental cell in our series of cases was relatively large with indistinct cytoplasm. There was no intercellular bridging. The cells grew in a loose syncytium, in narrow columns which infiltrated the surrounding submucosal tissue, or in tightly packed sheets. Lymphocytic infiltration was either marked or clearly evident. The cell nuclei varied somewhat in size but were usually rather large and round, or oval with sharp nuclear membranes. They were moderately hyperchromatic. Nucleoli were numerous and stained deeply. The cytoplasm was indistinct, moderately basophilic and varied considerably in amount in different slides. The cells seemed in several instances almost sarcomatous in appearance, yet in others bore a resemblance to reticulum cells. The number of mitotic figures was high. There was little difference in the appearance of the section regardless of whether taken from primary lesions located in the fossa of Rosenmüller, the faucial tonsil or near the pharyngeal tonsils. Those from the large polypoid tumors were similar to those obtained in the flat infiltrative lesions. Of great interest was one section, taken from a recurrent polyp several months after irradiation, which showed cells that were definitely more adult and differentiated in appearance than were the original sections, before irradiation.

CLINICAL FINDINGS

Even when the disease had reached an advanced state the diagnosis was often difficult to make. Unless the tumor, itself, had reached large proportions, the primary lesion was easily overlooked. On occasions, when all clinical signs pointed to the presence of this disease, repeated nasopharyngeal examinations were necessary before the lesion was located. Although it can usually be seen with a mirror, it has, in several instances, been found only with a

Fig. 4. Polypoid growth arising in vault of nasopharynx (retouched).

nasopharyngoscope. The latter instrument is also valuable in observing the effect of irradiation on the lesion.

The symptoms were variable and often vague and confusing. They resembled, as Woltmann puts it, "a melange of head symptoms." Patients complained of "double vision," "sinus aches," "severe toothache," "facial neuralgia," "deafness," "roaring or clicking" in one ear, and difficulty in breathing through the nose. There was blindness in one eye, ptosis, internal strabismus, dilatation of the pupil, severe pain in the face and jaw, difficulty in swallowing, trismus, deviation of the uvula or tongue, and other findings indicative of cranial nerve involvement.

Many of the patients gave a history of fruitless operations. Two patients had had mastoidectomies, 1 repeated sinus operations, and 8 repeated insufflations of the eustachian tube. Three had had paracenteses, 5, dental extractions, 1 an ethmoidectomy for proptosis, actually due to invasion of the orbit. New commented upon the large number of operations in his series.

A unilateral compression of the eustachian tube occurred early in the disease in 12 instances. This is usually a minor symptom and is described as a clicking sound or a roaring and may be associated with a serous discharge. A careful interrogation is usually necessary to obtain this history. Most patients will suffer a definite diminution of hearing in one ear by the time they come for treatment. One case, which had been diagnosed as primary lymphosarcoma of the cervical lymph nodes, while under radiation treatment was observed to be deaf in one ear and an examination of the nasopharynx revealed the primary lesion. Since it was so commonly associated with rhinitis and pharyngitis, little attention was paid to its presence except for repeated attempts to relieve it by insufflation of the tube or paracentesis. Early involvement of the tube may not occur if the primary lesion is located elsewhere than the peritubal region, but this was the earliest and most common symptom in this series. It usually preceded by many months the onset of cranial nerve involvement.

Cervical adenopathy was the next most common finding. In many instances, it was the first sign of disease. Various writers

Fig. 5. Early cervical metastases in same patient.

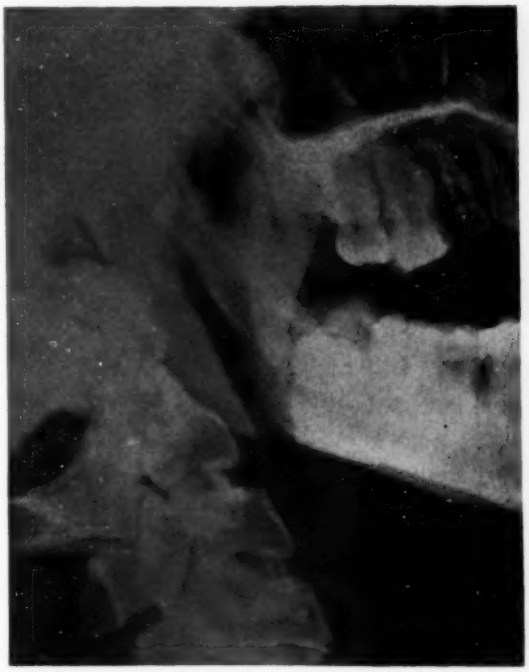

Fig. 6. Same case, four weeks after irradiation.

Fig. 7. Mentovertex view before irradiation.

have found adenopathy present in as high as 80 per cent of their cases. The nodes may vary considerably in size and are often painful. It is difficult to decide whether the pain arises in the nodes themselves or is due to involvement of the upper cervical nerves and branches of the fifth cranial nerve. Involvement is usually bilateral and since the nodes are usually smooth, firm, discrete and not fixed to the skin, the diagnosis of Hodgkin's disease or primary lymphosarcoma is often made. Metastatic cervical nodes were the second most frequent finding in our cases, being present in 9 on admission and eventually in 11 patients. The earliest to appear was the lateral retropharyngeal node on the affected side. This could be palpated just behind the angle of the jaw, and displaced the lobe of the ear outward and backward. Later, the deep cervical chain, lying along the anterior border of the sternocleidomastoid muscle became involved. Eventually nodes appeared in the posterior triangle and supraclavicular space.

There was cranial nerve involvement in 9 cases. This was unassociated with any other signs or symptoms (except those referable to the euastachian tube) in only 4 cases. It is interesting to note that these 4 were patients of a neurosurgeon, who suspected the presence of a nasopharyngeal lesion from the pattern of cranial nerve pathology. Roentgenography of the skull demonstrated invasion of the middle fossa before the primary lesion was discovered. All 4 cases had had previous nasopharyngeal examinations and 2 extensive mastoid and sinus surgery.

The sixth nerve is the one reported most often involved by New, Woltmann, and Martin and Blady,[14] C. L. Martin,[12] and others, but only 5 of our cases exhibited lateral rectus paralysis. The presence of intransigent pain over the distribution of the second and third divisions of the fifth in 8 cases and of the first division in 3 of the 8 made this nerve the most commonly affected in this series.

Epistaxis occurred in 4 cases and in 2 was the only symptom. One of these ex-

Fig. 8. Same patient as in Figure 7, fourteen days later.

hibited a lesion of the faucial tonsil which was easily found. The other a small flat nodule in the fossa of Rosenmüller. Both were early lesions with no invasion or metastasis and are the only 2 in the series living and free of all evidence of active disease.

Nasal obstruction was present in 4 cases. In 1 case a polypoid growth had extended forward from the epipharynx into the nares and was easily visualized through a nasal speculum. Only 1 case showed infiltration of the soft palate and paterygoid muscles.

Six cases eventually suffered invasion of the orbit with proptosis, which was always a late development.

Distant metastases complicated 4 cases late in the course of the disease. Two were in the upper dorsal spine and the other in the long bones of the legs. Occurrence of mediastinal and pulmonary metastases, as described by C. L. Martin[12], was not observed.

The age distribution was rather unusual, although it corresponds, in general, with that given by other authors. Seven patients were under twenty years of age and 9 were over twenty. Of these, 7 were fifty or over. The youngest case was aged ten and the oldest fifty-seven. Two patients were brothers, ten and fifteen years old respectively. When receiving the report of the death of the eldest we also heard that a small child in the family was dying of enlarged glands in the neck.

The distribution between the sexes was almost even, 9 male and 7 female. Most reports show a preponderance of males. Five of the 9 male patients were under twenty.

TABLE I

Case No.	Sex	Age	Duration of Symptoms before Diagnosis	Location of Metastases	Roentgen Dose to Primary Lesion	Survival Period
1	M	54	16 mo.	Cervical; cranial	2100 r	Died in 15 mo.
2	M	10	6 mo.	Cervical	2100 r	Died in 6 mo.
3	M	18	4 mo.	Cervical	2350 r	Died in 6 mo.
4	M	19	2 mo.	Cranial	2700 r	Died in 6 mo.
5	F	55	1 mo.	None	3500 r	Free of disease
6	M	18	4 mo.	None	2390 r	Free of disease
7	F	52	16 mo.	Cervical	2600 r	Died in 24 mo.
8	F	48	3 mo.	Cervical	2650 r	Died in 7 mo.
9	F	15	4 mo.	Cranial; cervical	3200 r	Died in 12 mo.
10	F	17	6 mo.	Cranial	1350 r incomplete	Died in 7 mo.
11	M	20	2 mo.	Cervical; cranial; spine	Palliation	Died in 5 mo.
12	F	34	14 mo.	Cervical	3200 r	Free of disease
13	M	42	24 mo.	Cervical	1800 r	Died in 7 mo.
14	M	55	22 mo.	Cervical	2000 r	Living with disease
15	F	50	6 mo.	Cranial	Treatment finished elsewhere	Living with disease
16	M	58	10 mo.	Cervical; cranial	2100 r	Living with disease

The duration of symptoms, before diagnosis, was quite variable, often surprisingly long. The shortest symptom period was one month (epistaxis); the longest was two years (tinnitus), with most cases from four months to two years in duration.

The primary lesion was in or adjacent to the fossa of Rosenmüller in 10 instances, the palatine tonsil in 3, the pharyngeal tonsil in 2 and unknown in 1 case. The primary location did not seem to influence the cell type, the degree of malignancy, the course of the disease or the radiosensitivity of the tumor.

Roentgenographic studies have been

helpful in establishing the diagnosis and evaluating the extent of the process. Lateral and mentovertex views of the nasopharynx and oropharynx often showed luminal defects on the posterior and lateral walls. Even when the lesion, as observed on direct examination, was small, it was surprising how thick the posterior retropharyngeal wall was. Since this usually regressed under treatment it is assumed that it is a measure of the amount of malignant infiltration. In several, in which such thickening was present, there was but a small break in the mucosa and the first several biopsies were negative. This emphasizes Martin and Blady's statement that the biopsies must be taken deeply, and probably explains why surface biopsies were often negative. It also probably explains the apparent discrepancy between the size of the visible primary lesions and the remarkable extent of the disease process.

Views of the base of the skull were not routinely taken on the first few cases, but were on the later ones. Mentovertex or base views are difficult to interpret as the foramina are not always symmetrical and the amount of cartilage is variable. It has been found necessary to make several views at slightly different angles to visualize all the foramina to best advantage. Erosion was found most frequently around the foramen ovale, foramen lacerum, the body of the lesser wing of the sphenoid, and the petrous apex. One case showed definite erosion of the jugular foramen. Roentgenograms should always be made before starting treatment as the size and position of fields may be determined by the findings. They also provide an excellent record of the effect of treatment.

Table II

Case No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
Primary Location*	T	P.T.	F.R.	F.R.	T	F.R.	F.R.	F.R.	P.T.	F.R.	?	F.R.	F.R.	F.R.	F.R.	F.R.	2 T 2 P.T. 11 F.R.
Eustachian Tube Involvement	Yes	No	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	12 yes
Nerves Involved	II III	No	No	III IV V VI	No	No	V	V	V VI	IV V VI VII IX	V VI	No	No	III V VI IX Symp.	V C-1 C-2	No	9
Adenopathy	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	10 yes
Angina	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	No	Yes	No	Yes	No	No	8 Yes
Nasal Obstruction	No	No	No	No	No	Yes	No	Yes	Yes	No	No	No	No	No	No	Yes	4 yes
Invasion of Orbit	Yes	No	No	Yes	No	No	Yes	No	Yes	No	Yes	No	No	No	No	Yes	6 yes
Epistaxis	No	Yes	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No	3 yes
Distant Metastases	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No	4 yes
Previous Operation	No	1	No	2	No	No	1	1	No	1	3	1	No	No	2	2	9

* T = Faucial tonsil P.T. = Palatine tonsil F.R. = Fossa of Rosenmüller

THERAPY

Although Regaud in his original description of lymphoepithelioma emphasized its sensitivity to irradiation, total reliance on this method of therapy was slowly accepted by the medical profession in general. As late as 1929 Gardham[8] described a surgical exposure to permit direct attack on the lesion; he along with earlier writers has expressed disappointment in the results and prognosis. However, Quick and Cutler, C. L. Martin, H. E. Martin and Blady and

others have emphasized the extreme radiosensitivity of the malignant process and have shown some encouraging results. The use of high voltage roentgen radiation alone or combined with radium or radon has become the accepted method of treatment.

The high degree of malignancy and infiltrative character of the disease plus the location of the primary lesion make adequate surgery an impossibility. It is quite true that results are still not wholly satisfactory, but if the disease is diagnosed early enough so that irradiation can be given before invasion or metastases have taken place, the possibility of eradication of the disease is anything but hopeless.

It is probably superfluous to state that each patient presents a specific problem and that no routine method of treatment can apply to all. It is our general procedure to examine each patient with the otorhinolaryngologist in order to observe the primary lesion and the extent of infiltration in the nasopharynx. Frozen and permanent paraffin sections are studied with the pathologist to determine cell morphology. The extent and location of neurological involvement, if present, is charted by the neurosurgeon. The size and location of other metastatic lesions must also be taken into consideration. If cervical nodes are so located as to be included in the beam directed at the nasopharynx, this field may be larger than normally used. If the enlarged nodes are in the lower cervical region or supraclavicular space, separate fields are required. On some occasions it will be necessary to direct treatment first to some lesion other than the nasopharynx, if it is producing very distressing symptoms. After a sufficient dose is administered to this area the primary focus can then be attacked.

Fig. 10. Abducens paralysis (base view Fig. 9).

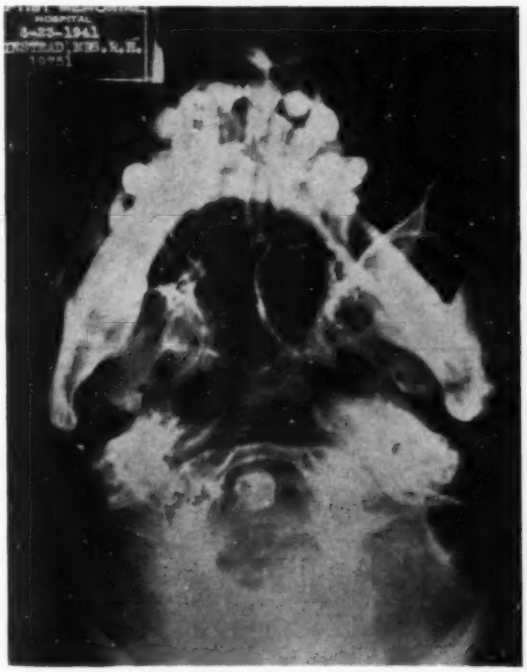

Fig. 9. Destruction of left petrous apex and both greater sphenoid wings.

It has been possible to treat the primary lesion first in most of these cases. We have usually adhered to the principle of using moderately small portals accurately directed. It is believed that the use of a field approximately 7 cm. in diameter will cover the primary lesion in the nasopharynx including the usual area of extension in the base of the middle fossa. The smaller fields permit a slightly greater dosage with less skin damage and pharyngeal discomfort.

Fig. 11. Bilateral invasion of lesser sphenoid wings.

The depth dose is slightly less than with larger fields but the increased dosage permitted will make up this deficiency. It is also possible to add several more fields without danger of substantial overlapping.

Occasionally when the preauricular or upper deep cervical nodes are large, a circular field 10 cm. diameter is used directed in the coronal plane through each temporal area. When the total dose to each field approaches 1,500 to 2,000 roentgens (in air) (2,000 to 2,600 with backscatter) the field is narrowed to 7 cm. and the dosage increased to 3,000 to 3,500 r (in air) (4,000 to 4,500 with backscatter) to each field. On some occasions when the primary lesion was small and it was not believed that diffuse infiltration of the nasopharyngeal wall had occurred a field 5 cm. in diameter was used. As our experience with the disease increased two additional fields were added, a circular beam 5 cm. in diameter was directed through the cheek on either side of the nose so directed as to cross-fire on the lesion. When this field was used, it was necessary to protect the cornea with a lead shield. A sheet of soft lead was inserted in the mouth and molded around the teeth, similar to a dental mold, to protect the tongue and lower teeth. The patients soon learned to fit it in place before each treatment. The paranasal field also gave an additional amount of irradiation to the invaded area in the base of the skull. In 5 instances in which there was exophthalmos and unquestionable invasion of the superior orbital fissure, additional fields were located both above and lateral to the orbit in order to include the floor of the anterior fossa.

A potential of 220 kv. (peak) at 20 ma. and 60 cm. target-skin distance has been used on all patients. The filtration has been varied from 0.5 mm. Cu and 1 mm. Al added to 2 mm. Cu or a No. 2 Thoraeus filter added. The majority, however, have been treated with 0.5 mm. Cu and 1 mm. Al which gives a half-value layer of 0.9 mm. Cu. We have been unable to observe any difference in results following the use of heavy filtration. It is probable that a slightly higher total dosage could have been

Fig. 12. Small nodular lesion of the left fossa of Rosenmüller. Note amount of infiltration in retropharyngeal wall.

administered with a little less skin reaction but the treatment of a large number of patients daily has prevented the use of prolonged treatment periods. The 20 kv. addition and 60 cm. target-skin distance almost compensates for the slightly greater depth dose obtained with heavier filter. The daily dose has varied slightly, depending upon the size and number of fields used, the general condition of the patient and his reaction to the treatment. It was not always possible to treat each patient as we might have desired or as our experience indicated.

It was believed that due to the anaplastic nature of the tumor cells a high total dose should be attained quickly and the majority of patients were treated with a daily increment of 300 r (in air) (390 r with backscatter). Yet it was observed that our best results were obtained in 2 cases with a dose of 200 r (in air) (260 r with backscatter) to one area daily. This prolonged the treatment period to the primary lesion to thirty or forty days and in neither case was there any evidence of extension or metastasis.

Cervical metastases were usually treated through a separate field, with a daily dosage of 300 r (in air) and a total dosage of from 2,000 to 3,000 r. The nodes ordinarily began to shrink and pain began to subside after the first several days of treatment. In most cases the dosage was sufficient to reduce the node considerably or accomplish a complete regression. Several of the patients experienced a recurrence of nodes which might have been prevented with a larger dose. Recurrent nodes failed to respond as satisfactorily as on the first series of treatments. When involvement of the cranial nerves had occurred it was possible to produce a temporary palliation of pain but no case in which a complete paralysis had been initially observed ever obtained a return of function. Several times paralyses occurred some time after the series of treatments, even though the probable areas of intracranial extension had been irradiated.

An estimate of tumor dosage has been given for each case. However, frequent observations of the effects of irradiation and the experience of the radiation therapist in treating these lesions is probably more important. Mathematical estimates of tumor dosage are apt to be erroneous since they are estimated at one or two levels and so infiltrative a tumor may lie at various depths. It was also observed that the tumor varies considerably as some react well to small doses while others will recur after large doses.

Fig. 13. Distribution of radon seeds around right palatine tonsil.

In some of the cases, external irradiation was not carried to as high a dosage as was considered possible because intracavitary treatment supplemented the external treatment. When the primary site was accessible, radon seeds were implanted by the otolaryngologist. Usually ten to fifteen 1 millicurie seeds gave a sufficiently even dosage to the focus. When the lesion was located in a less accessible area of the nasopharynx, a radium capsule was held against it by a Martin-Blady applicator or similar apparatus. With this the filtration was 1.3 mm. platinum plus variable amounts of

rubber. The dose ranged from 10 to 15 erythema doses per unit area.

Intracavitary irradiation was not given to those cases in which considerable infiltration of the nasopharynx was present. It can only be of value when the primary lesion is unquestionably limited in area.

Cervical adenopathy was treated with external irradiation only. It was not believed that cervical resection was advisable even though there was no tendency on the part of the metastases to rupture the nodal capsule.

One patient had had a block resection of the anterior deep cervical chain before the diagnosis was established. When first seen there was adenopathy on the opposite side of the neck. Both sides were irradiated and the only recurrence noted was in an area other than the resected region.

The question of giving so-called prophylactic irradiation when no cervical adenopathy is present is a difficult decision to make. Since cervical metastases develop so frequently it would seem wise to irradiate the neck routinely, particularly since the tumor is composed of cells so radiosensitive that the objection to such prophylactic irradiation in the more differentiated tumor processes may not hold. The possibility of administering a cancericidal dose is better than in the less sensitive tumors.

However, it was believed that the patients who showed no evidence of metastases should not be subjected to heavy irradiation and it was not believed worth while to administer less than a cancericidal dose. The 3 patients who are living and free from disease did not receive treatment to the neck. The other 6 cases which did not present cervical adenopathy on admission received treatment to these nodes only when they appeared. If enlarged nodes appear after a considerable period following irradiation of the primary focus it indicates that the primary focus is still active and should have been treated more aggressively.

One of the most distressing symptoms is the severe anginal pain experienced over the distribution of the branches of the fifth, ninth and the upper cervical nerves. It has not been possible to effect more than a temporary palliation by irradiation. Various measures have been undertaken in an effort to relieve this pain, namely cocaine, saline and alcohol injections. Drs. R. E. Semmes, J. F. Murphey and Antonio Grino have used the procedure of tractotomy as introduced by Sjöqvist[21] and modified by Olivecrona[16] and Weinberger and Grant.[23] This operation consists of surgical transection of the descending tract of the trigeminal nerve in the medulla. It is also possible to section the ninth nerve and the first and second cervical roots at the same operation. The procedure is carried out under local anesthesia. A straight incision is made in the low occipital region. The fourth ventricle is exposed by hemilaminectomy of the first cervical vertebrae and removal of a part of the posterior margin of the foramen magnum on the affected side. The operation involves little risk in the hands of an expert neurosurgeon and has been successfully carried out on 3 patients with excellent results. It is much preferable to division of the sensory root of the gasserian ganglion and it avoids an operative approach through a field infiltrated with malignant tissue and which has been impaired by irradiation. In addition, there remains a moderate degree of tactile sensation in the areas enervated by the fifth, which is not true of the ganglionectomy.

RESULTS

No attempt has been made to tabulate percentages as the series is too small to make such estimates accurate. One case would change the percentage figures by too great an amount. None of the 3 patients who are living and free of evidence of the disease has survived more than two and one-half years. Three others are alive but with active disease. These 3 were practically hopeless when first seen. The results are modified by the fact that all patients are given treatment, no matter how far advanced the disease is when first seen. This is observed in the tabulation which shows

that 7 patients survived only six months or less. Five of those had far advanced intracranial extension before treatment.

The degree of malignancy is much higher in those under twenty. Metastases occur earlier, intracranial extension is more rapid and severe and distant metastases more frequent. The process is more apt to be prolonged and amenable to treatment in the age group above fifty unless the general physical condition is poor.

SUMMARY

Transitional ephthelial cell carcinoma of the nasopharynx is not a rare disease. The diagnosis is often made too late for successful treatment. It affects all ages and sexes and is exceedingly malignant in children and young adults.

The most common site of the primary lesion is in or near the fossa of Rosenmüller or the pharyngeal tonsils. One of the earliest symptoms is referable to obstruction of the eustachian tube. Later symptoms are referable to a polypoid obstruction of the nasopharynx, invasion of the cranial cavity and metastases to the lymph nodes of the neck. Distant metastases are common.

Radiation therapy is the accepted method of treatment and offers the most hope at this time, whether it be complete arrest or palliation. Those cases treated before metastases or intracranial extension has occurred can expect the best results.

I am greatly indebted to Drs. R. E. Semmes, Wm. D. Stinson and John J. Shea for their permission to use these cases and their aid in assembling the necessary clinical information.

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CALCIFICATION IN THE DUCTUS ARTERIOSUS*

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THE roentgenographic demonstration of calcification in the mitral and aortic valves, annulus fibrosus and coronary arteries has been described by various authors and is now commonplace. Calcification in the arch of the aorta, pericardium, myocardium and endocardium is also well known.[1,2,3,4,5] No attempt has been made to search the literature completely, but to the best of our knowledge calcification in the ductus arteriosus has not been recognized during life, although various authors examining autopsy material have described microscopic areas of calcification in this structure. Jager and Wollenman,[6] in a careful study of the ductus arteriosus in 71 cases, representing a range from 28 mm. fetuse to adults eighty years of age, state that hyalinization, calcification and even cartilage formation occur in the older age groups. They note that the intima of the pulmonary artery and aorta becomes thickened over the obliterated ends of the ductus arteriosus and that atheromatous plaques in this region are a common occurrence in the aortas of adults, even in the absence of atheromatous lesions elsewhere in the aorta.

MATERIAL

Our interest in the occurrence of calcification in the ductus arteriosus has been stimulated by finding relatively marked calcification in this structure in an infant who came to autopsy at the age of nine months and fourteen days and also by the roentgenograms of 3 other patients, 2 infants and 1 child, which seem to reveal calcification in the ductus.

While most types of calcification in and around the heart are best recognized by roentgenoscopic examination, the calcified areas in our 3 living cases have been shown first in roentgenograms and in only 1 case has it been possible to confirm it by roentgenoscopy. This is not surprising as such calcified areas are very small, but as the body thickness at these ages is slight, roentgenograms show very fine detail provided that movement is prevented by short exposure time. Slightly overpenetrated chest roentgenograms are necessary to show the shadows distinctly.

CASE REPORTS

Case 1 (Autopsy No. A-44-24). Joan P. This white female infant was admitted to another hospital at the age of three and a half months where a diagnosis of a feeding disturbance was made. She remained in that institution for sixteen days and at that time the blood Wassermann and tuberculin tests were found to be negative. Feeding difficulty persisted to some extent following her discharge and three convulsions occurred when she was eight months of age. She did well for the next month but died rather suddenly at the age of nine months and fourteen days at the Protestant Foster Home Centre following three more convulsions.

Postmortem examination at the Children's Memorial Hospital showed that there was a rounded perforation in the posterior wall of the stomach with generalized peritonitis. Bacteriological examination of the peritoneal contents revealed multiple organisms. The remainder of the examination was negative except for the ductus arteriosus which was closed but felt firm and gritty. There was no abnormality of the heart. Roentgenographic examination of the removed specimen confirmed the presence of a calcified area in the ductus arteriosus and showed it to be 1 cm. in length and from 1 to 3 mm. in width (Fig. 1). A portion of this calcification had a crescentic outline. Unfortunately, no roentgenograms were ever made during life, but it seemed obvious that there was sufficient calcification so that it could have been recognized with ease in a chest roentgenogram.

Microscopic examination of serial sections of the ductus arteriosus using hematoxylin eosin, trichrome, and elastic tissue stains revealed the typical structure of a small caliber artery, with

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several exceptions. The internal elastic lamina was much more prominent than normal, and the vessel was closed. The lumen was occluded throughout the length of the vessel by a relatively acellular hyaline connective tissue in which a few blood vessels were visible. In this hyaline connective tissue there were irregular plaques and granules of calcified material. Adjacent to some of the larger plaques of calcium there were cells which resembled osteoblasts, so that an impression of new bone formation was given (Fig. 2).

The amount of calcium present in the obliterated lumen varied considerably from one end of the vessel to the other and was more plentiful at the aortic end. No calcification was found in the media or adventitia.

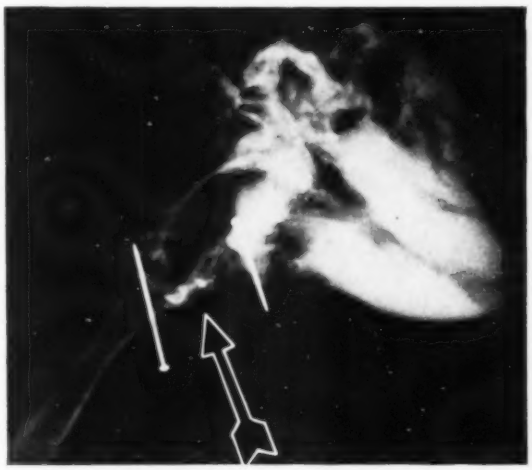

FIG. 1. Case I. Roentgenogram of removed heart and great vessels showing extensive calcification in the ductus arteriosus. One pin has been placed in the aorta and the other in the pulmonary artery so that the ductus lies between them with the calcification opposite the point of the arrow.

CASE II (Hosp. No. 24,239). G. L., a white male infant who was admitted to the Children's Memorial Hospital at the age of eight months. Except for a period of five months he was observed in hospital until he was twenty-six months of age. The entrance complaint was failure to gain weight and when he first came under observation he weighed only 11 pounds. In spite of adequately supplemented diet his weight had increased to only 13 pounds when he was finally discharged. No satisfactory explanation for his failure to gain was found in spite of the most exhaustive investigations all

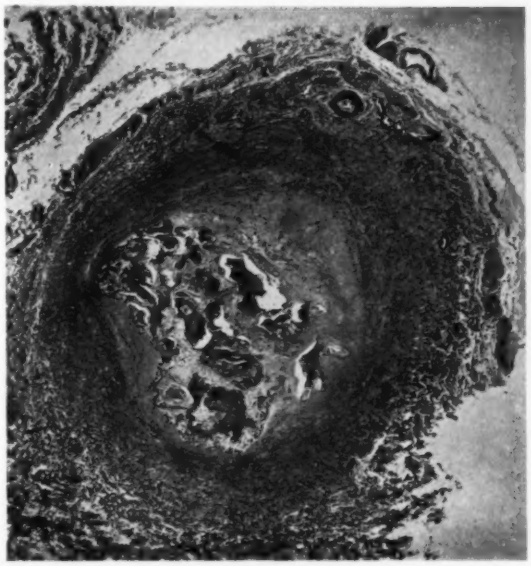

FIG. 2. Case I. Photomicrograph of the ductus arteriosus showing islands of calcium in the fibrous tissue obliterating the lumen. Hematoxylin and eosin stain, 30×.

of which were either inconclusive or non-contributory. The tuberculin and Wassermann tests were negative and at no time were any adventitious heart sounds noted. No abnormalities of the blood calcium, phosphorus or phosphatase were present.

Roentgenographic examination of the chest

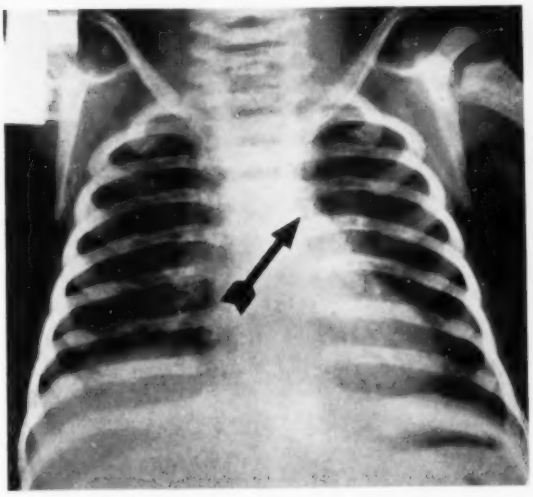

FIG. 3. Case II. Posteroanterior roentgenogram of chest made at eight months of age. The calcified shadow is crescentic in outline and lies just to the left of the vertebral column opposite the fourth interspace posteriorly.

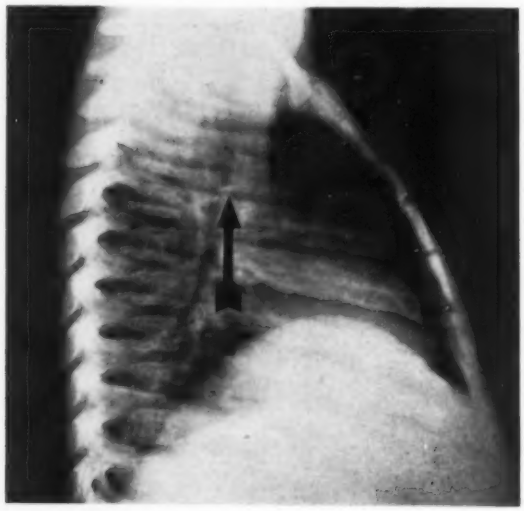

Fig. 4. Case II. Right lateral view of chest at age of two years. Calcification is visible opposite the point of the black arrow.

was carried out on nine separate occasions during his stay in hospital. The heart was not enlarged. Rather linear increased density persisted at the right base, and this neither increased nor diminished appreciably. The only other positive finding was a crescentic area of calcification 3 mm. in diameter situated just to the left of the vertebral column on a plane opposite the second rib anteriorly and fourth interspace or fifth rib posteriorly (Fig. 3). The exact relationship to the ribs varied slightly in different roentgenograms suggesting that it was situated neither directly anteriorly nor posteriorly in the chest. As time went by, the shadow gradually became slightly denser and formed a slightly more complete circle but there was very little if any increase in diameter. Just before he was discharged it was visualized in right and left anterior oblique and direct lateral views (Fig. 4 and 5). The length was approximately 1 cm. and its posterior limit was about the same distance in front of the vertebral column. It lay just to the left of the bifurcation of the trachea and roentgenoscopic examination indicated that it moved with the pulsations of the adjacent vascular shadows.

Case III (Hosp. No. 26,805). J. C. L. This white male infant was first admitted to the Children's Memorial Hospital at the age of nineteen days when a diagnosis of pyodermia was made. He was discharged as improved thirteen days later. At the age of five and a half months he was re-admitted for fifteen days. On this occasion the diagnoses were infected eczema, right-sided lobular pneumonia and phimosis. General investigation at this time revealed a negative Wassermann test, negative urinalysis, serum calcium 9.8 mg. per 100 cc., plasma phosphorus 5.46 mg. per 100 cc., and serum phosphatase 13.9 Bodansky units. The Patch test had been negative at the time of his first admission and a tuberculin test was not performed. Examination of the heart revealed no enlargement nor murmurs.

Roentgenographic examination of the chest on the day of his second admission revealed a linear type of infiltration extending throughout a good deal of the right lung. There was a congenital anomaly involving the second rib on the right, a bony projection extending upward toward the first rib in the anterior axillary line. In addition, there was a tiny calcified area about 2 mm. in diameter lying 5 mm. to the left of the vertebral column opposite the second rib anteriorly and the fourth interspace posteriorly. The presence of an artifact was excluded by a second roentgenogram made the same day, which showed exactly the same shadow.

The parents were persuaded to bring the infant back for re-examination on July 7, 1944, at which time he was exactly a year old. Posteroanterior, right and left anterior oblique and lateral roentgenograms of the chest were then made. The size of the calcified shadow had not changed appreciably and it was opposite the

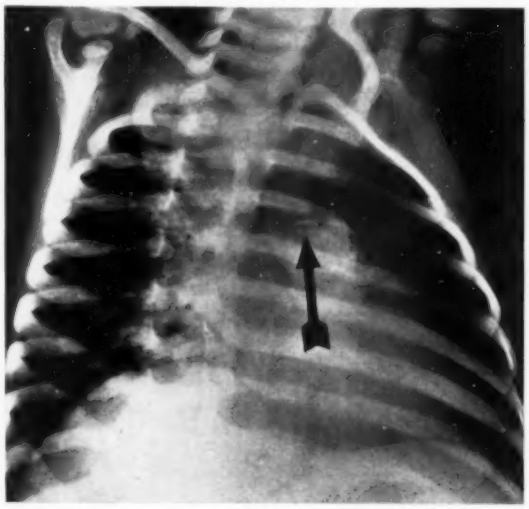

Fig. 5. Case II. Right anterior oblique view of chest showing calcification in the ductus arteriorus.

second rib anteriorly and sixth rib posteriorly just to the left of the vertebral column. In the right anterior oblique view, it was farther from the vertebral column, just to the left of the bifurcation of the trachea and opposite the right side of the second segment of the sternum. It could not be recognized in the lateral or left anterior oblique views.

Case iv (Hosp. No. 24,872). James P., a white male infant who was first seen in the Out-Patient Department at the age of twenty-one months at which time he was suffering from an upper respiratory infection with mild bronchitis. One year later when he was two years and nine months old he was admitted to the Children's Memorial Hospital suffering from a right upper lobe pneumonia, phimosis and a distended bladder. The blood Wassermann was negative and examination of the heart revealed no enlargement nor cardiac murmurs. He was discharged four days later.

A posteroanterior roentgenogram of the chest made on the day of admission showed somewhat faint consolidation in the right upper lobe. The only other finding of note was a ring-like shadow 3 mm. in diameter resembling calcification close to the left border of the vertebral column opposite the sixth interspace posteriorly and the upper margin of the second rib anteriorly (Fig. 6).

Re-examination of the chest six months later showed the lung fields to be clear. The calcified shadow was again visible and had not changed in the slightest degree in size, shape, density or position. It was faintly shown in a right anterior oblique view lying just to the left of the bifurcation of the trachea opposite the fifth interspace posteriorly. The tuberculin test was negative at this time.

DISCUSSION

Extensive calcification in the ductus arteriosus at the age of eight months and fourteen days is conclusively proved in Case i as shown by postmortem examination. It would seem that this calcification was sufficiently dense so that it could have been readily shown in a roentgenogram had the chest been roentgenographed before death. No other abnormalities of the heart or great vessels were found and the ductus arteriosus was closed.

A similar type of calcification has been repeatedly shown in Case ii from the age of eight months up to the age of twenty-six months. This occupies a position in the chest corresponding to the ductus arteriosus, as shown by examination in four planes, and it pulsates with the adjacent vascular structures. During this eighteen months' period it has become a little denser but not appreciably larger. Although this child is an example of extreme marasmus of unexplained origin it has never been possible to demonstrate any abnormality of the heart or great vessels, and the findings

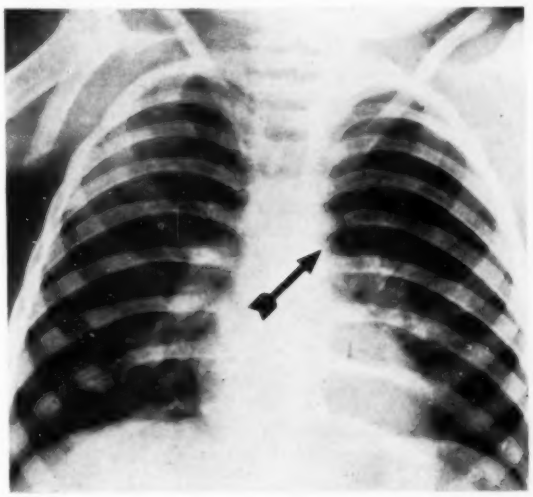

Fig. 6. Case iv. Roentgenogram of chest made at age of twenty-one months. The calcified shadow lies opposite the point of the arrow and while difficult to see in this reproduction it is plainly visible in the original roentgenogram. Somewhat faint consolidation is present in the right upper lobe.

and course have tended to exclude tuberculosis.

In Case iv the calcification is less evident, but its position is practically identical to that in Case ii. There has been no change during the six months' period that this child has been under observation. Except for one attack of pneumonia, an upper respiratory infection and phimosis he has thrived in a normal manner.

The calcification in Case iii occupies the same position as that in Cases ii and iv

but it is of more homogeneous density and not of a ring-like or crescentic shape. It has only been shown in posteroanterior and right anterior oblique roentgenograms, but there seems to be good evidence that it lies in the ductus. It was first noted at five and a half months, the youngest age of any of our patients.

As a general rule, calcification in the chest in infants and children should be considered tuberculous in nature until proved otherwise. However, tuberculous calcification before the age of six months is extremely rare and it is uncommon under the age of one year. When present, it is usually accompanied by extensive pulmonary infiltration and glandular enlargement and there is almost invariably clinical evidence to support a diagnosis of tuberculosis. A crescentic type of calcification such as that shown in Cases II and IV must be very unusual in tuberculosis, particularly when it is shown that no appreciable change occurs over a relatively long period of time. In the cases reported above no significant glandular enlargement has been demonstrated on any occasion either in the chest or elsewhere in the body. In Case II there are chronic changes in the right lung, but these have not increased nor decreased, neither have they calcified and all the other evidence including the tuberculin test has been against a tuberculous etiology. In Cases III and IV there have been typical pneumonias which have resolved rapidly following sulfonamide therapy and subsequent roentgenograms have shown complete clearing.

There is nothing to suggest that the ductus arteriosus is patent in any of our patients. Calcification has not been observed by us in any of the 18 cases of patent ductus arteriosus which have been operated on by Dr. Dudley Ross, at the Children's Memorial Hospital.

SUMMARY AND CONCLUSIONS

A proved example of moderately marked localized calcification in the obliterated lumen of the ductus arteriosus of an infant nine and a half months of age is reported. No other congenital anomalies were present. Calcification presumably in the ductus arteriosus has been found in the roentgenograms of the chests of two other infants and also in one child two years and nine months of age.

Although such macroscopic calcification does not seem to have been reported previously, it is probable that other instances may be found now that the possibility is known to exist. It does not appear to be of any clinical importance, but it should be differentiated from other lesions such as tuberculosis with which it may be confused.

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ROENTGENOLOGICAL ASPECTS OF THERAPEUTIC PNEUMOPERITONEUM IN PULMONARY TUBERCULOSIS*

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ALTHOUGH the use of artificial pneumoperitoneum in the treatment of pulmonary tuberculosis has been accorded general acceptance during the last decade, the roentgenological literature contains very little information on this subject. This is the more surprising since artificial pneumoperitoneum has been used extensively in roentgenological practice for diagnostic purposes and has also been recently recommended by Sante[17] as an adjuvant in the roentgen therapy of pelvic organs. Moreover, its application in intra-abdominal tuberculosis has been a standard procedure for almost half a century.

The history and rationale of pneumoperitoneum therapy in pulmonary tuberculosis are very interesting. The observations on which this form of treatment is based go back as far as Hippocrates and Sydenham (Fishberg[7]). They are founded on the experience that tuberculous women get along unusually well during the second and third trimesters of pregnancy, i.e. during that period of gestation when a marked physiological elevation of the diaphragm exists. This experience is so striking that, in 1700 and 1800 Cullen and Warren, respectively, recommended pregnancy in the treatment of pulmonary tuberculosis. A phthisiologist of the immense experience of Fishberg states that he never saw a pregnant woman die of tuberculosis.[7] On the other hand, we all are familiar with the frequent disastrous results which follow this temporary improvement after parturition, i.e. after the physiological elevation of the diaphragm has ended and the diseased lung has expanded again. One of the original aims of pneumoperitoneum application, therefore, was to continue this diaphragmatic elevation post partum by substituting air for the enlarged uterus.

The technique of therapeutic pneumoperitoneum is not different from that employed in diagnostic pneumoperitoneum. A detailed description may therefore be dispensed with. There is still no agreement about the best location for the air injection: some prefer McBurney's point; some, Rovsing's point; some, the midline; some, other points near the umbilicus, while still others advocate the so-called "subphrenic route" (just below the site of the costophrenic angle).

Some employ local anesthesia; others consider it unnecessary.

Sterilized atmospheric air, oxygen or nitrogen is used. Dependent on the type of gas used, the terms of "pneumoperitoneum," "oxyperitoneum" or "nitroperitoneum" have been employed by different authors. This differentiation is not without significance from a clinical viewpoint since, to a certain degree, the gases used determine the time of absorption and, consequently, the necessity of refills. While refills with oxygen are necessary about twice a week, they may, as a rule, be limited with air to once a week and with nitrogen to about once every two weeks. In intra-abdominal lesions there is also supposed to exist a difference in curative effect, and for this purpose oxygen is generally preferred. In a purely roentgenological consideration, however, this difference may be neglected, and the term "pneumoperitoneum" is therefore used comprehensively in this paper to include all types of gases used.

The amount of gas injected is increased,

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as a rule, with each successive injection, starting with about 200 to 500 cc. until an optimum of about 1,500 cc. is reached. The injections should be done under both manometric and roentgenoscopic control. Extreme pressure is to be avoided since it may interfere with the patient's intake of food and so may hasten the clinical downward course.

The total duration of pneumoperitoneum treatment varies according to symptoms and results. Like pneumothorax, it should not be extended indefinitely.

The indications for pneumoperitoneum treatment in pulmonary tuberculosis have been formulated by Banyai,[1,2,3] Hobby,[10] Stokes,[18] and others.

Pneumoperitoneum may be applied either (1) as an independent therapeutic agent or (2) preparatory or supplementary to other forms of collapse therapy.

As an *independent measure*, pneumoperitoneum appears indicated in cases in which collapse therapy seems advisable but in which the other more orthodox forms of such therapy (like pneumothorax, phrenic block or thoracoplasty) are unsuitable or too hazardous. This postulate applies especially to cases with considerable bilateral involvement and extensive pleural adhesions; cases of severe pulmonary hemorrhage which cannot be controlled by any other means; then women following pregnancy (especially when pneumothorax cannot be induced); cases with reactivation after abandonment of pneumothorax; cases of advanced age and debility, and, finally, cases in which pulmonary tuberculosis is complicated by intestinal or peritoneal tuberculosis, by basal bronchiectasis, basal emphysema or allergic bronchial asthma.

Burge[5] includes as indicated all cases in which no functioning lung tissue can be spared since, in his experience, pneumoperitoneum does not tend to increase dyspnea. He further adds causes of unexplained chronic abdominal pain, vomiting and repugnance to food.

However, the chief field of pneumoperitoneum treatment lies in its combination preparatory or auxiliary to other forms of collapse therapy.

Rudman[16] recommends pneumoperitoneum as a *trial measure* to determine diaphragmatic mobility or freedom from interfering subdiaphragmatic adhesions prior to phrenic interruption or preparatory for radical surgery. Kaufman[11] believes that, by pneumoperitoneum, thoracoplasties can occasionally be prevented and that, employed before pneumothorax is attempted or immediately following the discontinuance of an ineffective pneumothorax, many complications of pneumothorax therapy may be avoided.

As an addition to *phrenic nerve block*, pneumoperitoneum is indicated if the elevation of the diaphragm is insufficient or when, despite an apparently satisfactory diaphragmatic rise, cavities persist and the sputum remains positive.

According to Raine[14] the combination of pneumoperitoneum and phrenic block may double the effective (unilateral) collapse achieved by diaphragmatic paralysis alone, while Brian and Ricen[4] estimate that, used without preliminary nerve crush, pneumoperitoneum is only 25 per cent effective.

As an addition to *artificial pneumothorax*, therapeutic pneumoperitoneum is indicated when relaxation of the basal portions of the lung is desirable but cannot be achieved by pneumothorax alone on account of adhesions or other impediments.

Similarly, *thoracoplasty or the paraffin pack* may be supplemented by pneumoperitoneum when lesions in distant portions of the lung remain active.

Undoubtedly the best results are obtained in cases where pneumoperitoneum can thus be combined with other forms of collapse therapy. In this way pneumoperitoneum treatment may reach lesions which remain uninfluenced by other measures. Rilance and Warring,[15] for instance, found that, by a combination of pneumoperitoneum and phrenic crush, the best results were obtained in cavities of the generally less accessible lower lung zone. A compari-

son of indications and results shows that pneumoperitoneum neither competes with, nor is intended to replace, the other forms of tuberculosis therapy.

Needless to say, pneumoperitoneum should not be reserved as a desperate last resort for hopeless cases; such use would only serve to discredit the method.

As contraindications to pneumoperitoneum Vajda,[21] Banyai and Stokes enumerate the following: (1) complete fixation and non-mobility of the diaphragm on the diseased side; (2) stiff-walled cavities or acute miliary disease; (3) reduction of the vital capacity of the lungs to less than one-third; (4) cardiac decompensation or diseases of the coronary artery, and (5) marked arteriosclerosis, amyloidosis or renal disease.

One definite advantage of the method is evident: its complete reversibility compared with phrenic block or thoracoplasty. From pneumothorax, which usually is only little less reversible, it distinguishes itself by the relative paucity of untoward sequelae and complications.

Among immediate sequelae are mentioned shoulder pain (similar to that experienced in liver or gallbladder disease); a feeling of tightness across the upper abdomen and the lower chest (most prominent after induction and the initial refills), and, occasionally, nausea and vomiting, especially in toxic patients.

The complications reported in the medical literature comprise ascites, intestinal perforation (very rare), peritoneal inflammation, atrophy of the diaphragm, air embolism, massive atelectasis, accidental pneumothorax, mediastinal emphysema, cardiac decompensation, enlargement of inguinal and umbilical hernias, and scrotal pneumocele (Monto and Bradford[13]).

It is obvious that in the determination and evaluation of both indications and contraindications as well as in the technique of administration and the diagnosis of the complications, roentgenoscopic and roentgenographic examinations are indispensable. In all these questions the roentgenologist may be of great help to the phthisiologist.

In the application of pneumoperitoneum, manometric measurements should be supplemented, as mentioned above, by roentgenoscopic control. The demonstration and evaluation of the type and extent of the pulmonary lesions, of pleural adhesions, diaphragmatic excursion, bronchiectasis, cardiovascular and renal disease, gastrointestinal complications, etc., belong to the realm of roentgenologic diagnosis.

Of equally great importance are the roentgenologic determination and evaluation of the direct and remote effects of the pneumoperitoneum treatment.

The roentgenologically directly observable effects of pneumoperitoneum are: (1) elevation of the diaphragm (which, as a rule, is bilateral though frequently unequal on both sides, and which may reach 10 cm. or more) combined with a corresponding limitation of diaphragmatic movements; (2) diminution of lung volume (which may amount to 15 to 35 per cent reduction of chest capacity) combined with compression of cavities, "crowding" of the bronchovascular markings and corresponding changes in the appearance of tuberculous lesions as well as of the heart and mediastinum; (3) separation of the subphrenic viscera, especially the stomach, liver and spleen, from the diaphragm, and (4) disappearance of intra-abdominal adhesions.

The effectiveness of the pneumoperitoneum and the final results depend on these factors which must be ascertained by clinical and roentgen examination and which demand close medical supervision. Whether the healing process proper is more the result of pulmonary rest, of better drainage of the bronchial tree and the cavities, of pulmonary congestion, lymph stasis or anoxemia lies beyond the scope of roentgenological observation.

Of complications ascites is probably the most frequent finding in the roentgenogram. According to Fowler[8] it occurs in about 3.8 per cent of the cases but rises to 45 per cent in terminal cases according to Trimble, Eaton and Moore.[20]

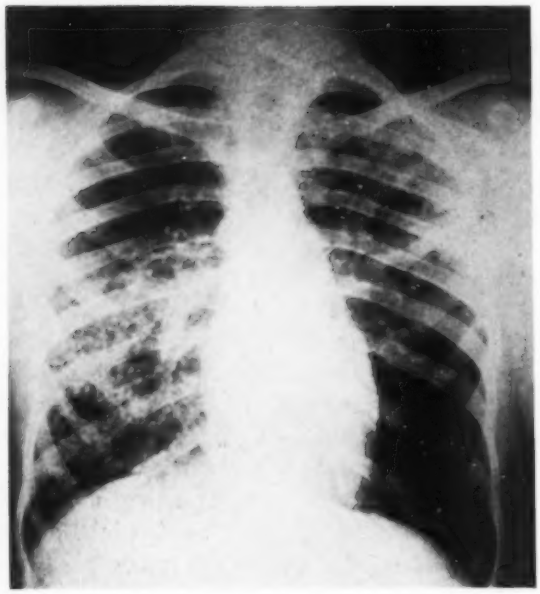

Fig. 1. Case 1. Extensive exudative cavernous changes in right lower and middle lobes and in left upper lobe.

During the past year, I have had opportunity roentgenologically to observe 61 tuberculous patients treated with pneumoperitoneum at the National Jewish Hospital in Denver. This means that the method, either independently or in connection with other forms of collapse therapy, was employed in about 25 per cent of all patients. Thirty-six of the patients were men, 25 were women. In the large majority of cases the pulmonary involvement was bilateral and, in a high percentage, pneumoperitoneum was auxiliary to phrenic block or pneumothorax. In 5 cases, it was combined with thoracoplasty; in 1 case, with Monaldi cavity drainage. The youngest patient of this series was ten years old, the oldest sixty-seven; 43, i.e., 70 per cent of the patients, were more than thirty years old. Five patients were children fifteen years or younger; 4 of these children were of Spanish-American descent.

The duration of pneumoperitoneum treatment varied from one month to almost four years (forty-six months).

While the usual lighter sequelae, like shoulder pain and initial tenseness, occurred, none of these cases suffered from the severer complications which have been pointed out in the literature.

As a matter of fact, the scarcity of untoward symptoms and the absence of complications undisputably attributable to pneumoperitoneum treatment was most surprising. Only 4 patients presented symptoms that called for roentgen examination of the gastrointestinal or genitourinary tracts. Considering the large number of tuberculous patients who "normally" have such complaints, it almost appears (as has been claimed by some authors) that pneumoperitoneum exerts a definitely beneficial influence on these organs.

Three deaths occurred among patients of this series. In none of these deaths could a causal connection between type of treatment and fatal outcome be assumed.

It is, of course, impossible to judge definitely about final success or failure in many cases of such an eminently chronic and unpredictable disease. This is particularly true if the pneumoperitoneum treatment is of too short a duration to produce any appreciable effects or is only a minor factor in the clinical and therapeutic picture.

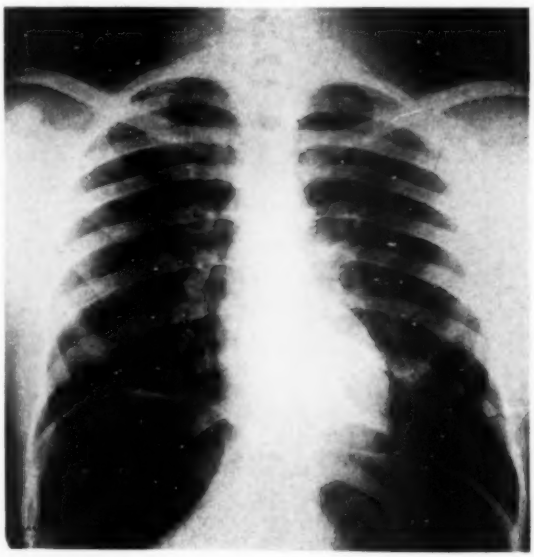

Fig. 2. Case 1. Status two years after phrenic crush and pneumoperitoneum. Lung fields are now practically clear.

However, in other instances fairly definite conclusions are permissible, and a few representative cases and significant roentgenograms will be briefly discussed.

CASE REPORTS

Case I. A. K., schoolboy, aged fourteen. A refugee from Germany, he was hospitalized for pulmonary tuberculosis two days after arrival in this country (July, 1941). Admitted to the National Jewish Hospital the following month he showed very extensive exudative cavernous involvement of the right lower and middle lobes as well as of the left upper lobe (Fig. 1). Phrenic crush was done in September, 1941, followed by artificial pneumoperitoneum two days later. In spite of a relatively moderate elevation of the diaphragm (about 4 cm. on the right, 2 cm. on the left), the pulmonary lesions have practically disappeared (Fig. 2). Sputum and temperature have been normal for over two years.

An important factor deserves mention in this connection, i.e. the advantage of pneumoperitoneum in children over a possibly complicated pneumothorax and over a mutilating thoracoplasty. We know that the latter two methods when applied during the years of development and physical growth may result in marked deformities of the chest and bony thorax. This danger is entirely absent in pneumoperitoneum treatment.

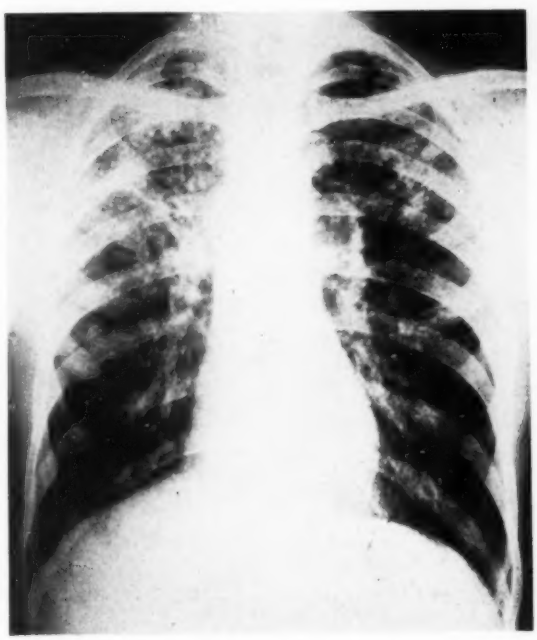

Fig. 3. Case II. Far-advanced tuberculosis of both upper lobes.

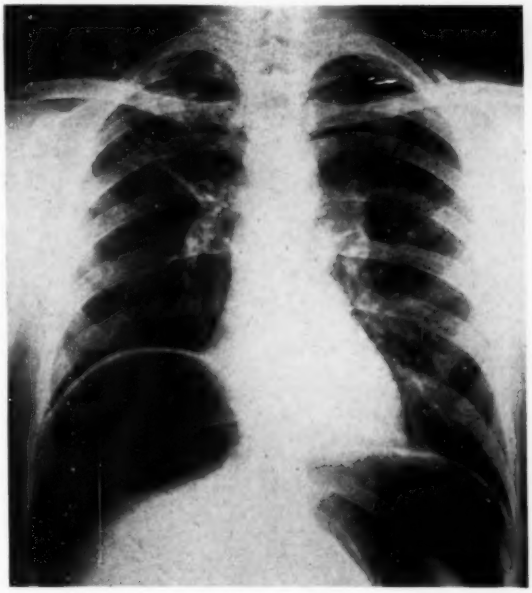

Fig. 4. Case II. Status about one year following pneumoperitoneum and phrenic crush. Marked improvement of all pulmonary lesions.

Similarly good results were achieved by the combination of pneumoperitoneum and phrenic block in the following 2 cases.

Case II. E. K., aged twenty, office boy, was admitted to the National Jewish Hospital in February, 1943, with the diagnosis of far-advanced tuberculosis of both upper lobes (Fig. 3). Because of extensive bilateral involvement and pleural adhesions, neither pneumothorax nor thoracoplasty was feasible, and pneumoperitoneum treatment was begun in May, 1943, supplemented three months later by right-sided phrenic crush. The result as seen in the roentgenogram taken on August 18, 1944, is highly satisfactory (Fig. 4). The right diaphragm has risen about 8 cm.; the left, about 5 cm. Of the previous extensive pulmonary involvement only some fibrosis in both upper lobes and some clouding of the right apex still remain. The patient feels well. The sputum has been negative for almost half a year; the temperature is normal.

Case III. F. W., aged thirty-two, book-

Fig. 5. Case III. Extensive exudative involvement and large cavity in left lower half. Numerous small type calcifications bilaterally.

keeper, with a history of pulmonary tuberculosis since 1934. Sanatorium treatment in 1935, and from July, 1940 to February, 1942. In the intervals, patient worked or went to school. Admitted to the National Jewish Hospital in December, 1942. The left phrenic nerve had been crushed in July, 1937, and was re-crushed in October, 1943. Pneumothorax was attempted but without success. On account of this failure and in view of the predominantly basal location of the lesions, artificial pneumoperitoneum was applied in November, 1940, and has been continued ever since, i.e. for a period of almost four years. During all this time, weekly fillings of 500 to 1,000 cc. of air have been administered, and a very marked bilateral elevation of the diaphragm has been maintained (about 8 cm. rise on the right and up to 14 cm. on the left). The intra-abdominal pressure after filling averages +10 to +12. Temperature and pulse which were elevated on admission are now normal; the sputum is negative.

Fig. 6. Case III. Status after three years of pneumoperitoneum treatment combined with left phrenic crush and re-crush. Practically no more evidence of pulmonary lesions.

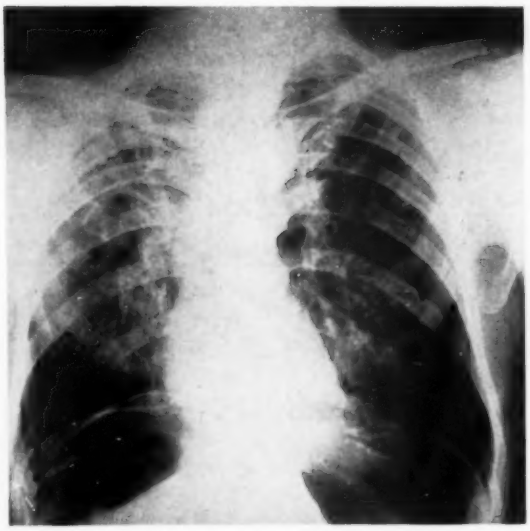

Fig. 7. Case IV. Limitation of diaphragmatic rise by subphrenic adhesions. Fixation of hepatic flexure of colon between liver and diaphragm.

The roentgenogram before application of pneumoperitoneum (November 29, 1940) shows very great exudative changes and a large oval cavity in the left lower half combined with numerous small type calcifications scattered throughout both lung fields (Fig. 5). The second roentgenogram three years after initiation of the pneumoperitoneum treatment shows about 8 cm. rise of the right diaphragm and about 13 cm. rise on the left, compared with the pre-pneumoperitoneum roentgenogram. The previously prominent cavernous exudative lesions in the left chest have entirely disappeared (Fig. 6). The abdomen shows the typical "bunching together" of the viscera but it is worthy of note that, despite these marked intra-abdominal

changes, the patient is without symptoms or complaints.

Case IV. This case, L. W., aged forty-nine, plasterer, demonstrates the limitation of pneumoperitoneum treatment in the presence of widespread subphrenic and abdominal adhesions. In spite of a large amount of subphrenic air, the elevation of the diaphragm is insufficient to produce any noticeable pulmonary changes (Fig. 7).

I shall conclude with a case which is less remarkable with regard to the pulmonary or therapeutic aspects than it is representative of the abdominal findings generally encountered in pneumoperitoneum.

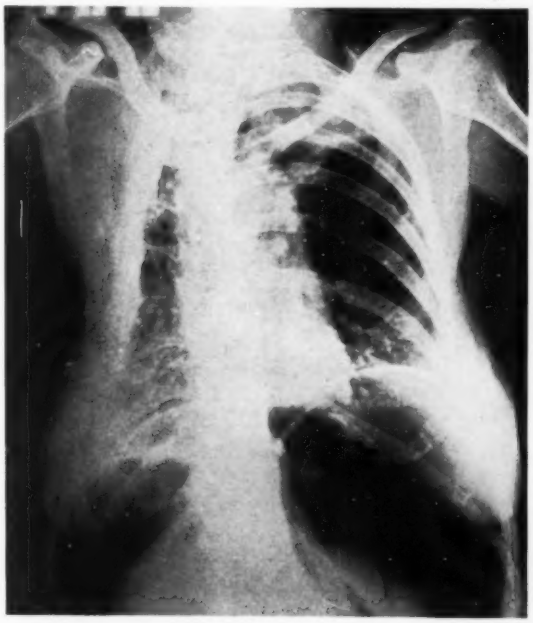

Fig. 8. Case v. Thoracoplasty, right, with incomplete collapse and pneumoperitoneum. Exudative cavernous changes in left apex.

Case v. I. T., aged thirty, school teacher, has been suffering from secondary pulmonary tuberculosis since 1930. Even before that time, in 1919, she spent some time in a sanatorium for childhood tuberculosis. In 1933, pneumothorax of the right side was applied but, due to pleural adhesions, the result was unsatisfactory. The following year, an unsuccessful attempt at pneumonolysis was made, followed by a phrenic crush. Then, in 1935, a three-stage right-sided thoracoplasty was performed but an extension

Fig. 9. Case v. Status immediately following barium meal. Normal position and outline of stomach. (Prone position.)

of the tuberculous process to the left side with cavitation followed the operation. In January, 1940, patient was admitted to the National Jewish Hospital, and pneumoperitoneum treat-

Fig. 10. Case v. Status twenty-four hours following barium meal. Normal position of colon. (Prone position.)

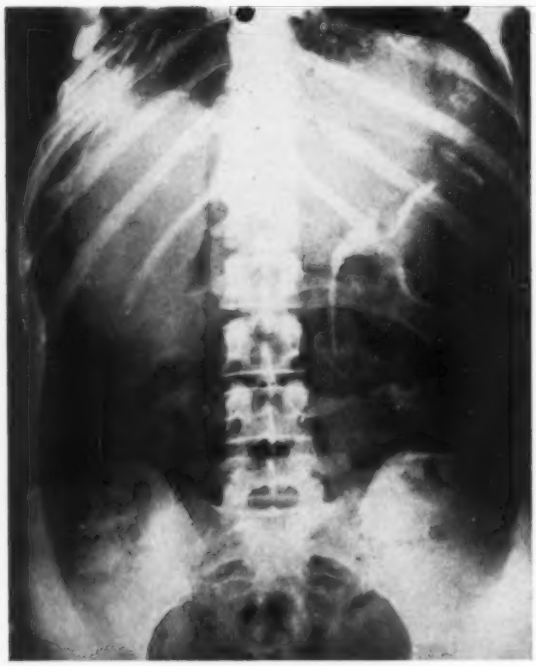

Fig. 11. Case v. Intravenous pyelography. Normal filling of renal pelves and calices. Air accumulation in left abdominal region simulating large cyst. (Supine position.)

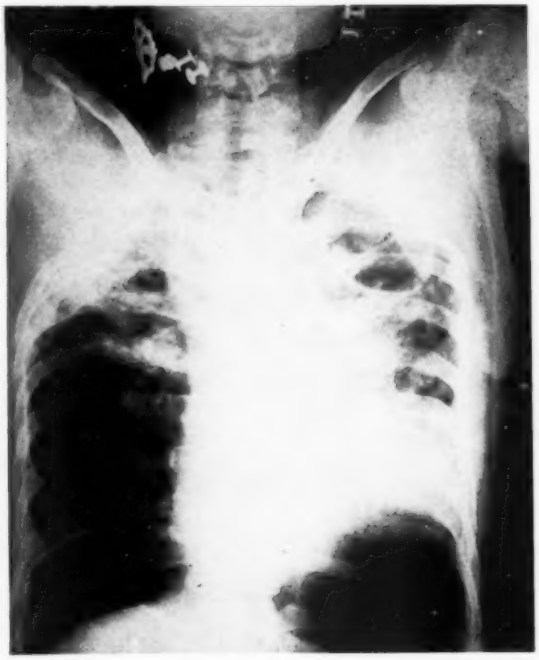

Fig. 12. Case vi. Postmortem examination. Appearance and position of chest and abdominal viscera practically identical with antemortem appearance.

ment was inaugurated in April, 1942. The effect of the diaphragmatic elevation has not been sufficient to enhance the incomplete collapse of the right lung materially nor have the exudative cavernous changes in the left apex been appreciably improved (Fig. 8).

The abdominal roentgenograms present the typical appearance of diagnostic pneumoperitoneum which needs no further explanation. The considerable difference in appearance and contrast between roentgenograms in the prone and erect positions and those taken in the supine position is primarily due to the difference in air distribution. In the prone views and in the erect views the air accumulation is most prominent under the domes of the diaphragm; the liver, kidneys and spleen are "bunched together" and very sharply contrasted and delineated. There is very little change in the roentgen appearance of the stomach and the intestinal tract. Following barium filling, the stomach and colon almost seem to float in a void and show practically normal outlines and position (Fig. 9 and 10). This fact explains the relative lack of untoward gastrointestinal symptoms even in extensive and protracted pneumoperitoneum treatment.

In the supine position, the typical appearance of pneumoperitoneum disappears, and the striking conglomeration and contrast of the viscera, especially the liver, kidneys and spleen, no longer exist. Instead of largely occupying the subdiaphragmatic spaces and upper abdominal areas, the air now occupies the highest level of the peritoneal cavity and may be difficult to trace. In our roentgenogram, the highest air bubble lies in the left abdominal region and has the appearance of a large cyst extending from the calices of the left kidney (Fig. 11).

In none of our cases of pneumoperitoneum were we able to diagnose ascites or other intra-abdominal complications (adhesions excepted) roentgenologically.

Postmortem roentgen examinations were obtained in the 3 patients who died during pneumoperitoneum therapy. A comparison with the roentgenograms taken previously showed that the rise of the diaphragm and the other changes produced by pneumo-

peritoneum persist essentially unchanged after death (Fig. 12, Case VI).

SUMMARY

(1) A brief review of the history, rationale, technique, indications, contraindications, sequelae and complications of pneumoperitoneum therapy in pulmonary tuberculosis is given.

(2) The roentgenologic aspects of this form of collapse treatment are outlined with regard to pulmonary, diaphragmatic and abdominal findings.

(3) Six representative cases from the pneumoperitoneum material of the National Jewish Hospital in Denver are discussed.

The author wishes to express his thanks to Dr. Charles J. Kaufman, Medical Director of the National Jewish Hospital in Denver, for the privilege of using the clinical material and for many helpful suggestions.

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CONTRAST ROENTGENOGRAPHY OF THE PNEUMATIC CELLS OF THE TEMPORAL BONE

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WHEN an otologist prepares to operate on a case of mastoid disease, three questions on anatomy come up for consideration. First, is the mastoid cellular or solid? second, if cellular, how deeply and widely do the cells extend? and third, are the cells pneumatic or only spaces in cancellous bone?

The answers to these questions cannot be found by external inspection and palpation by the otologist. Even after the mastoid is opened and the cells exposed to the eye, it is difficult to answer the third question. It is not unusual for a surgeon, after exposing cell after cell, to remark "There is no use going farther, this is cancellous bone" and to stop further exploration.

Since the deep structures are hidden from sight and touch, the otologist must turn to the roentgenologist for the answers to these questions. The roentgenologist, however, using the conventional methods in vogue up to now, can give only partial help. He can answer the first two questions with excellent roentgenograms showing the most delicate tracery of bone formation. He can answer the third question, however, only inferentially. Given a roentgenogram that shows a number of cells grouped around the auditory canal in the mastoid region, it is reasonable to infer that the cells are mastoid cells. Operation will usually confirm the correctness of this inference. Such inferences, however, are not so easy when one deals with small cells around the periphery or in the petrous pyramid. Such cells, in fact, by reason of their small size and the amount and density of the surrounding bone, may not even appear in a conventional roentgenogram.

In order to differentiate between pneumatic and cancellous cells, I have devised the technique for contrast roentgenography of the temporal bone that I am about to describe. It can be used only where there is a perforated tympanic membrane, a mastoid fistula or both.

The procedure followed is, briefly, as follows. First, roentgenograms are taken in the conventional manner, including a view showing both mastoids and petrous bones from one exposure. Then an aqueous solution of a radiopaque salt is instilled into the middle ear and communicating cells. After this another series of roentgenograms is taken in the same positions as the first series. Comparison of the two series will show the cells that contain the opaque solution.

The technique of instilling an opaque solution into the tympanum and paratympanic cells is a new procedure and requires a more detailed description. It needs the closest cooperation between the otologist and the roentgenologist. Since the perforated drum membrane is usually accompanied by pus, swollen mucous membrane, and often polyps, it is necessary first to remove the pus from both tympanum and paratympanic cells and to shrink the soft tissues. The external auditory canal is cleaned by syringing or swabbing. Then the patient lies on his side on a table, with the diseased ear uppermost. A drop of a vasoconstrictor is instilled into the canal and allowed to act for about ten minutes. Then the external canal is filled with warm 2 per cent boric acid or sodium bicarbonate solution. This is allowed to seep in. The tip of a Siegle pneumatic otoscope is fitted tightly into the canal and the bulb is worked for about one minute. This causes alternate suction and pressure and creates a to and fro swishing of the fluid in the ear, helping to dislodge the pus and bring it to the sur-

face. After this the patient lies on his other side and the suction and pressure is applied while the ear is down. This draws the fluid out and allows air to replace it. This also is done for one minute. The patient turns the diseased ear up again and the same procedures are repeated five or six times till the washings return clear. The patient then lies with the affected ear down for five minutes to allow all fluid to drain out. The entire procedure takes thirty to forty minutes. Instead of an otoscope, a bulbous glass irrigator tip and a rubber bulb may be used. The use of a rubber bulb is very tiring on the hand and I have, therefore, installed a very slowly acting electric pump which makes about 60 revolutions per minute and can deliver suction and pressure at 150 mm. of mercury or less, as required.

After the ear is free of the cleansing solution, the patient is again turned with the affected ear up and the aqueous radiopaque solution is instilled into the canal. The pump is used again to help instill the fluid deeply. The patient is not turned over this time but is kept in the same position. If the opaque solution has disappeared from view, more is added. The capacity of the air cells is sometimes surprising. The cadaver specimen shown in the illustrations took 12 cc. of solution. The canal is now corked carefully to prevent leakage. A small medicine dropper bulb, closed end first, makes a good, comfortable stopper. If loose, its cavity can be packed to distend it. The second series of roentgenograms is now taken.

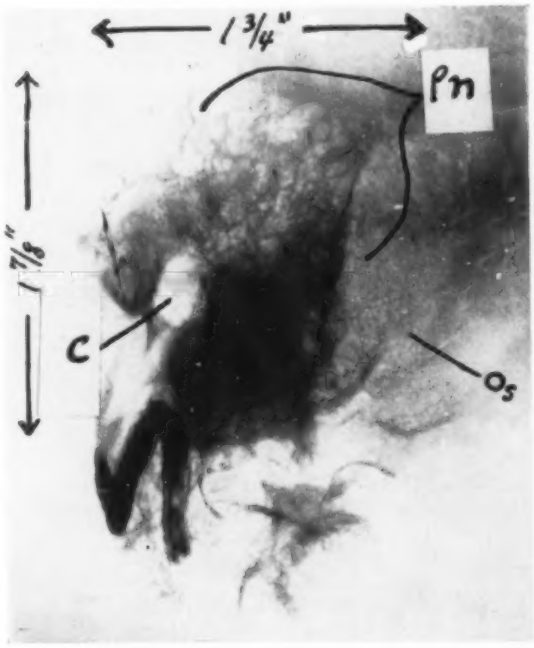

Fig. 1. Wet cadaver before injection of opaque material. *C*, canal; *Os*, bone cells; *Pn*, pneumatic cells.

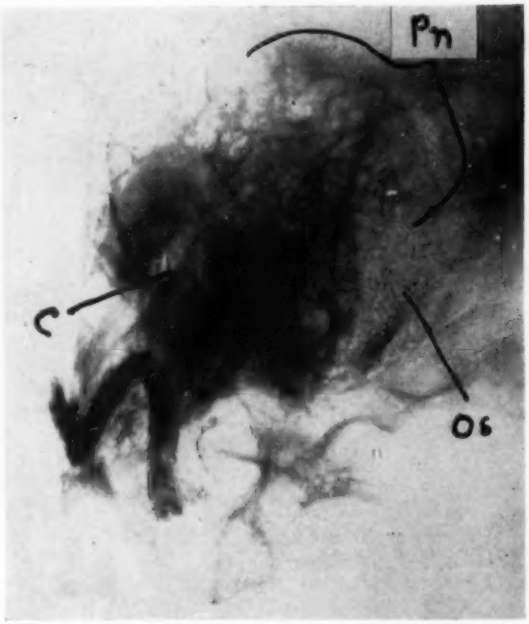

Fig. 2. Cadaver after injection of opaque material. *C*, canal; *Os*, bone cells; *Pn*, pneumatic cells.

A study of the roentgenograms of a wet cadaver specimen shown in Figures 1, 2, 3 and 4 is revealing. Figure 1 is a lateral view of a temporal bone *before* opaque solution was injected. The network of very small cells, lettered *Os*, is the osseous framework; the network of large cells, lettered *Pn*, are the pneumatic cells. Figure 2 is a roentgenogram of the same specimen in the same position *after* injection of opaque solution and shows the same air cells more heavily outlined and also brings out some peripheral cells not visible in Figure 1, especially in the mastoid region.

Figures 3 and 4 show still more interest-

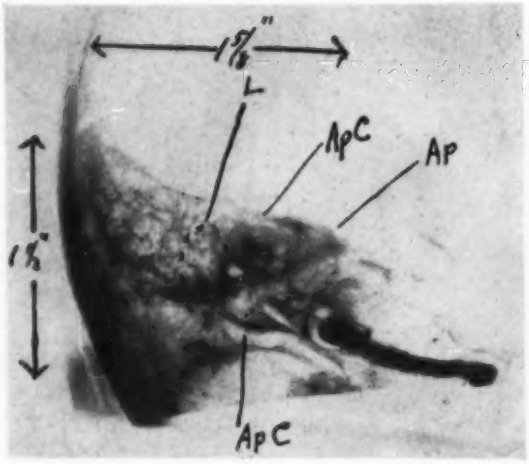

Fig. 3. Cadaver, horizontal view, before injection of opaque material. *L*, labyrinthine region; *Ap*, petrous apex; *ApC*, apical cells.

ing findings. They are horizontal views of the same specimen showing the whole length of the petrous pyramid. Figure 3 was taken before injection of opaque solution. The apex of the petrous bone can be clearly seen. The broken circle indicates the region of the cochlea and semicircular canals. Even without the opaque solution, a network of air cells can be seen overlying these structures and along the anterior and posterior borders of the petrous bone, cells

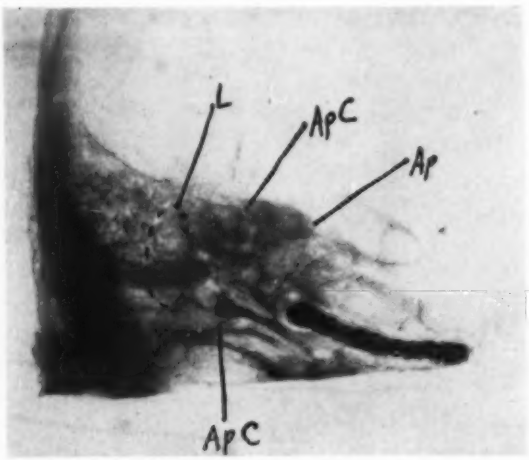

Fig. 4. Cadaver, after injection of opaque material. *L*, labyrinthine region; *Ap*, petrous apex; *ApC*, apical cells.

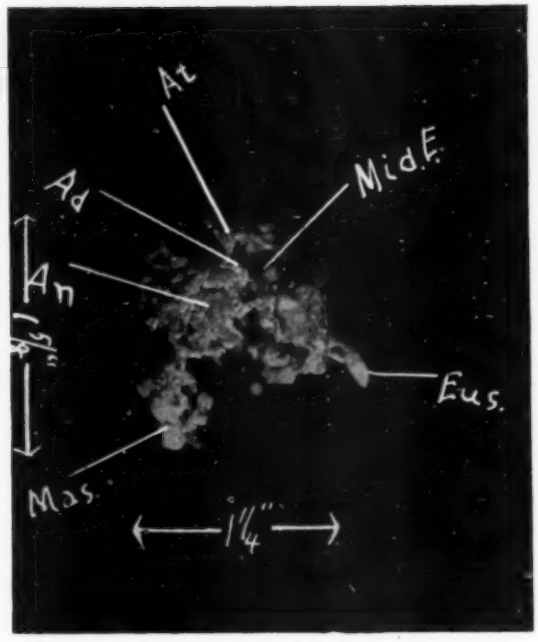

Fig. 5. Internal cast of previous specimen. Lateral view. *Eus*, eustachian tube; *Mid E*, middle ear; *At*, atticus; *Ad*, aditus; *An*, antrum; *Mas*, mastoid cells.

can be seen that extend to within ½ inch of the petrous apex. In Figure 4, the same specimen in the same position *after* the in-

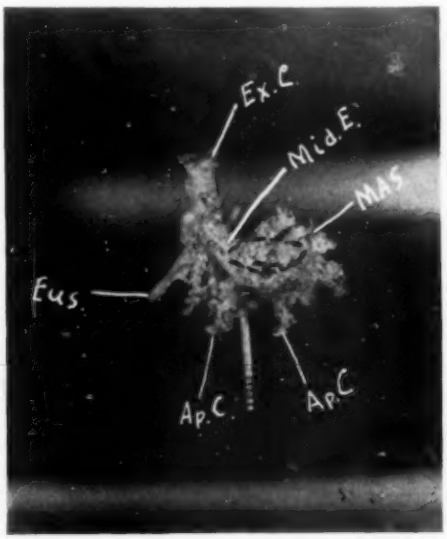

Fig. 6. Top view, previous specimen. *ExC*, external canal; *Eus*, eustachian tube; *Mid E*, middle ear; *Mas*, mastoid cells; *ApC*, apical cells.

jection of the opaque solution, the cells are more heavily outlined.

The importance of these findings is obvious. They show a continuous, if devious, aerial connection between the middle ear and petrous cells. This specimen is typical of many that I have studied. They undoubtedly offer an explanation of the path of infection in many, if not all, cases of petrous apicitis.

The presence of the opaque solution in the cells is positive proof that they are air cells, but any question of a shadow of a doubt is precluded by the findings in Figures 5 and 6. These are photographs of casts of the insides of the tympanum and paratympanic cells. The casts were made by injecting, under pressure, an acetone solution of a plastic (methyl methacrylate-polymer vinylite) through an opening in the drum membrane. After the plastic had solidified, the bone and soft tissues were dissolved by strong caustics, which did not act on the vinylite. The same specimen was used as in the previous studies. Before the cast was completely freed of its bony encasement, it was seen to approximate the dimensions shown in the roentgenograms (Fig. 1–4),

Fig. 7. Before injection of opaque material in patient.

Fig. 8. Same patient, after injection of opaque material.

but as it was freed from the bone, many peripheral cells were so delicate and their connections so tenuous, that they fell off during handling. The dimensions shown in Figures 5 and 6 are still large enough to indicate the extent of the pneumatic system of the temporal bone. Figure 5 is a lateral view, corresponding to the view seen in Figures 1 and 2, and Figure 6 is a view corresponding to that seen in Figures 3 and 4. The lettering indicates the parts. Particular attention is called to Figure 6, where it can be seen that the plastic material extends over and around the petrous labyrinth. Apical cells shown in Figures 3 and 4 extend well internal to the labyrinth. The ends were, unfortunately, broken off in handling and they do not extend as far as the air cells. It must be remembered that what appears solid in the picture is actually air space in the bone.

It is comparatively easy to take roentgenograms of the cadaver. If the ear is normal, it is only necessary to puncture the drum membrane to inject the opaque solution. If the ear is diseased, pus has dried up and polyps have shrunken. In the living, as stated earlier in this paper, we can take

these roentgenograms only if the drum membrane is perforate. In that case there is pus and, often, polyps. The pus must be washed out from the deep recesses and the polyps must be shrunk. This is a time consuming and painstaking procedure. Nevertheless, the information gained is worth the trouble. Figures 7 and 8 are roentgenograms in the case of a man who had chronic purulent otitis media for many years. Polyps protruded from the external meatus. In spite of this handicap, the roentgenograms show a marked difference in the outline of the cells.

Not all cases are so difficult. But difficult or easy, it is necessary that fuller and more exact information be obtained.

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MULTIPLE MARCH FRACTURES*

THE STATICODYNAMIC EFFECT

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THE term "march fracture" has emerged from the many names by which this clinical entity has been referred to, such as, "Fussgeschwulst," "pied forcé" "Deutschländer's Krankheit," "Marschgeschwulst," "pied débile," "pied de marche," "l'enflure du pied," "pied surchargé," and the like.

Around this group of descriptive terms were built up pathologic concepts equally contradictory, and intricately conceived. If one is interested in a very complete review of the growth of our understanding of march fracture, he should consult the excellent article by Meyerding and Pollock.[8]

In the present paper it is not intended to cover ground already so well explored, but before proceeding to the point of this article, it may be mentioned that Breithaupt thought the condition due to an inflammatory reaction in the tendon sheaths; Weisbach believed that it involved the ligaments rather than the tendons and called it "syndesmitis metatarsea"; Pauzat thought it due to the dorsal fold of the soldier's shoe, resulting in an "osteoplastic periostitis"; Poulet considered it a form of rheumatic diathesis; Deutschländer suggested a bacterial factor; Kirschner believed that it was induced by exhaustion of the muscles of the foot (and, incidentally, in 1905 decided that all cases were due to fracture, thus antedating his contemporaries by a considerable length of time in arriving at the truth of the matter).

The first roentgenogram depicting the condition is believed to have been taken by Stechow in 1897.

With further study of roentgenograms, the fracture line began to be described in some of them; then it began to be searched for in more of them; then, as roentgen technique improved, it began to be more frequently identified. One error in technique responsible for such lesions being overlooked is the practice of taking roentgenograms of the bones of the hands and feet using intensifying screens; such roentgenograms not only mask detail, but prevent the recognition of changes in osseous density which may occasionally give the clue to a disease process, such as a Sudeck's atrophy. In my observation, more than one fractured carpal navicular bone has passed unnoticed because the roentgenogram of the hand had been taken using intensifying screens.

As march fracture began finally to be more universally recognized in its true status, a rather voluminous literature filled with highly hypothetical etiologic concepts passed into oblivion. The situation is quite comparable to that obtaining in relation to "Kümmell's disease." During the years in which this interesting entity was regarded as a mystery, much discussion was carried on at various medical societies, but now that orthopedic surgeons are rather united in regarding "Kümmell's disease" as merely an overlooked compression fracture (due mostly to advances in roentgenographic technique), the subject has become neglected.

The question as to why march fractures occur in some individuals and not in others has swung the focus of inquiry closer to Morton's original concept of the "weak foot"; Morton and others have called attention to the short first metatarsal, the prevention of a proper weight-bearing thrust by the occurrence of certain types of sesamoids with the first metatarsal; Dodd,[1] quoting Shulte, thinks that protrusion of the second metatarsal is a predisposing

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FIG. 1. Simple fracture of first metatarsal.

FIG. 2. Healing of the fracture shown in Figure 1; the patient is walking on the fracture, and the callus is exuberant.

FIG. 3. Continued weight bearing on the outer side of the foot, the patient trying to protect the injured first metatarsal, and a resultant march fracture of the second metatarsal.

FIG. 4. The patient continues to walk; now he has a second march fracture. Note also how this weight bearing continues to influence callus production in the first metatarsal.

factor; Sloane and Sloane[10] discuss the theory that compression of the blood supply by the interossei in a flat foot may predispose to the condition.

Hauser[5] in his textbook calls particular attention to metatarsus latus and pes valgoplanus as predisposing factors, and also mentions the fact that march fracture has been seen following radical operations for hallux valgus.

The case to be described here illustrates the manner in which two consecutive march fractures were produced in a foot considered normal before the occurrence of a simple fracture of the first metatarsal (the march fractures following the simple fracture).

This patient, injured while at work by dropping a heavy object on the great toe, gave evidence of an ordinary simple fracture of the first metatarsal (Fig. 1). The foot was placed in a cast, and the patient sent home. When returning for observation some days later, the rather exuberant callus about the healing fracture was commented upon, and the patient, who was suspected of not being cooperative, was cautioned again about weight bearing.

The patient returned at a later date with a still more diffuse layering of callus about the shaft of the fractured metatarsal, and, in addition, a fracture through the neck of the second metatarsal.

The cast was reapplied, and the cautions about weight bearing reiterated. Perhaps our presentation of the cause and effect in the condition was not clear, but at any rate the point of the matter seemed to have escaped our patient, for he returned at still a later date with a healing march fracture of the third metatarsal bone, which appeared quite comparable at that stage to the healing march fracture of the second metatarsal.

CONCLUSIONS

We believe that we have here illustrated the effect of an altered weight-bearing thrust: a foot appearing in no way abnormal before the occurrence of the first metatarsal fracture becomes the site of two march fractures because the patient, keeping his weight off the great toe and walking on the outside of his foot, so altered his weight-bearing thrust that two typical march fractures resulted.

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CONTACT ROENTGEN THERAPY IN CANCER OF THE BLADDER*

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IN 1940 we described a method of treatment of cancer of the bladder by a combined surgical and radiation technique.[1] Briefly, the method consisted of marsupialization of the bladder with subsequent irradiation of the tumor by very low voltage roentgen rays with the tube in contact with the lesion. After a brief experience with this method, it was abandoned in favor of the simpler and more convenient plan of suprapubic cystotomy and direct irradiation of the tumor, with one or two re-openings of the bladder for further treatment.

Since we have now treated a total of 31 patients during a period of five years, it seems appropriate to review the results obtained and to attempt an evaluation of the method. We have in mind, moreover, the likelihood that, after the end of the present war, contact roentgen therapy will be in much more general use, and that our small experience in the treatment of cancer of the bladder should be available for the benefit of those who wish to undertake this method.

The technique which we have employed in all but four of the patients treated (i.e., those in whom the bladders were marsupialized) is fairly simple and, in the latter half of the series, became quite standardized. Under spinal anesthesia a classical suprapubic cystotomy is performed, exposing the tumor. After reduction of the mass to its base by fulguration, a dose of approximately 5,000 r is administered to the base of the tumor at a target-surface distance of 22 mm., the quality of the radiation being represented by a half-value layer of 1.0 mm. Al. The apparatus employed is the Philips-Metalix, operating at 50 kv., constant potential, and 2 ma. The roentgen tube is 23 inches long and slightly less than 2 inches in diameter at its active end. The anode is 2 cm. from the surface of the tube and the r afflux is 1,143 per minute with a filter of 1 mm. Al. The tube is entirely shockproof and may be held in the operator's hand, and its size and shape permits easy introduction through the cystotomy wound. After it has been well scrubbed with alcohol, it is placed in a sterile stockingette and covered with a sterile rubber sheath, under which conditions it may be introduced into the surgical field with impunity. Most cases treated had two cystotomies about one week apart and received a total dose of 10,000 r, although as much as 28,000 r has been given in twenty-two days.

In another communication[2] one of us has pointed out the danger inherent in what we might call the transliteration of the dosages named. It is very important to realize that it would be dangerous to administer a dose of 28,000 r under conditions other than those here described and that indeed it may be and likely is the case that the biological effect of the roentgen, with the very long wave length radiation employed, is quite different from that commonly experienced with more conventional radiation therapy.

Only moderate sloughing followed the treatment. In no case was there any serious hemorrhage, and there was no instance of perforation of the bladder or of fistula formation. There was no primary mortality.

Treatment has been limited to (*a*) tumors involving the trigone of the bladder and (*b*) tumors not more than 3 cm. in diameter. The size of the tumor is important, since those of more than 3 cm. diameter cannot

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be included in the irradiation field at contact, and since it is obviously impossible to employ multiple circular fields without either overlapping or leaving small irregular areas untreated. We have limited treatment to tumors involving the trigone because the alternative is total cystectomy with its high primary and secondary mortality. Neoplasms of the vault or lateral walls of the bladder may be treated by local resection and this, we believe, is preferable to radiation therapy when it can be performed. Rationalization of this combined surgical and radiation therapy procedure was as follows: Cancer of the bladder is, for a rather long time, a local disease, tending to metastasize only fairly late in its course. Most of these neoplasms are comparatively radiosensitive and the problem would seem to be simply the administration of a sufficiently large dose of radiation at the base of the tumor while avoiding irreparable injury to adjacent tissues. Suprapubic cystotomy and the use of the shockproof contact roentgen tube solves the problem of applying the irradiation to the tumor without loss of energy or the production of undesired irradiation effects in the overlying structures. Because of the very short target-surface distance (22 mm.), and the very low voltage (50 kv., constant potential) the depth doses are small, as shown in the accompanying table.

Circular field 3 cm. in diameter:
At 1 cm. depth.....32%
2 cm. depth.....13%
3 cm. depth..... 6.4%
4 cm. depth..... 3.6% surface dose

Thus protected by geometrical laws, very large doses may be administered without serious damage to underlying tissues.

Although little or no fault may be found with these assumptions, and in spite of the fact that the immediate results were impressive, a study of the 31 patients thus treated causes us to adopt a rather pessimistic attitude and serves to point the observation so frequently made that the local disappearance of a malignant tumor is not tantamount to its cure. Thirteen of the tumors treated were papillary carcinomas and 18 were infiltrating. Twenty-two of the tumors were graded and 9 were not classified as to degree of malignancy. Grade 3 tumors predominated with 11 tumors in this group. Six were in Grade 2, 3 in Grade 1 and 4 in Grade 4. All tumors treated involved some portion of the trigone or the bladder neck.

The number of treatments varied from one to eleven. Fifteen patients received two treatments each, 7 received only one treatment, 4 were treated three times, 1 had four treatments, and this group included all who underwent cystotomy for each treatment. Four patients (the first 4 treated) had marsupializations performed, after which 2 received ten and 2 eleven treatments. Those in the first group who received multiple treatments had them at approximately weekly intervals. Treatment of the marsupialized bladder occupied about three weeks, treatment being given on alternate days.

The total dose administered varied from a minimum of 5,148 r given in a single treatment to a maximum of 28,116 r, to those treated fractionally, all measurements being made in air. Fifteen patients had doses of about 10,000 r. Very large doses, approximating 28,000 r, were given to the 4 patients whose bladders were marsupialized.

Every patient treated had had a histopathological diagnosis, and in 20 of them a second biopsy was done at the final treatment. No cancer cells were found at the second biopsy in 13 of the 20 patients studied. The end-results achieved in the 31 patients treated are here summarized:

	Cases	Per Cent
Dead, but with no evidence of cancer at postmortem study	2	6.4
Dead, with cancer	10	32.3
Living, with cancer	10	32.3
Living, with no cancer	9	29.

Of those dead with cancer, 1 was a suicide whose treatment had not been concluded.

Of the 10 patients who died of cancer, 9 died in the first year after treatment, and 1

lived four years. There are 19 survivors and these have lived since treatment as follows:

	Cases
5 years	3
4 years	3
3 years	5
2 years	4
1 year	4

The advantages of the combined surgical and low voltage contact roentgen irradiation method in the treatment of cancer of the bladder are: (1) low primary mortality (none in our series); (2) low secondary mortality; (3) complete exposure of the tumor, permitting biopsy for microscopic study, and fulguration; (4) comparative simplicity as contrasted with total cystectomy or radon seed implantation.

The disadvantages are: (1) multiple cystotomies, two or more in most instances; (2) rather long hospitalization (four to six weeks).

The results, to be properly evaluated, must be compared with those following curative efforts by surgery, i.e., total cystectomy, radon seed implantation, and high voltage external irradiation. A series of 21 patients had total cystectomy performed at the Memorial Hospital with 5 operative deaths, or a primary mortality of slightly more than 23 per cent. Eight of the survivors are living and apparently well, 5 of them for more than five years, 2 for eighteen months and 1 for thirty months.[3] At the same institution, 205 patients had radon seed implantation, 38 per cent were said to be "controlled," and 19 per cent were free from cancer five or more years after treatment.[4] As to external irradiation, it is unlikely that many five year cures are effected with 200 kv. irradiation. Perhaps roentgen rays produced at higher voltages will offer hope of improved results, although the few statistics available do not offer much encouragement. Colby and Schulz[5] report 101 cases of cancer of the bladder treated with supervoltage roentgen therapy. Of this series 33 per cent have survived from one to five years with carcinoma and 12 per cent have survived one to five years without disease.

In conclusion, we may say that, having in mind the disadvantages and limitations of the combined surgical and low voltage contact roentgen irradiation technique, it is a useful addition to the few methods available for treatment of cancer involving the bladder trigone. We believe that its use should be limited entirely to the treatment of tumors not more than 3 cm. in diameter which involve the trigone or the bladder neck. Under these conditions, the results are probably at least as good as those obtained by any other method and, in view of the low primary and secondary mortality, the method is to be preferred to total cystectomy.

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VOL. 54, NO. 4

AN ANALYSIS OF THE PHYSICAL FACTORS CONTROLLING THE DIAGNOSTIC QUALITY OF ROENTGEN IMAGES*

PART II. MAXIMUM RESOLVING POWER AND RESOLUTION COEFFICIENT

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IN THE first of this series of articles,‡ the physical factors affecting the diagnostic quality of roentgenographic films and roentgenoscopic screens were analyzed. Beginning with the premise that the interpretability of a roentgen image is closely related to the ability of the recording film or screen to register detail, it was shown that diagnostic quality is dependent on the maximum resolving power of the roentgenographic film or roentgenoscopic screen, on a relatively minor factor called the resolution coefficient, on the contrast which the various roentgen images exhibit and the unsharpnesses of the images. It was further pointed out that the relationship between these several factors is given by the equation

$$R = R_m(1 - e^{-aC})(U_f/U_t) \qquad (1a)$$

where R is the resolving power or ability of the roentgenographic film or roentgenoscopic screen to record detail,

R_m is the maximum resolving power of the film or screen,
a is the resolution coefficient,
C is the contrast between an image and its surrounding field,
e is the Naperian base,
U_f is the inherent unsharpness of the film or screen and
U_t is the overall unsharpness with which an image is recorded (inherent unsharpness and extraneous unsharpness such as that contributed by anatomical movement and an excessively large roentgen tube target collectively).

Equation (1a) is valid for all contrast levels. For images of low contrast, however, the relationship may be expressed more simply by the equation

$$R = R_m aC(U_f/U_t) \qquad (1b)$$

In this communication, the significance of the maximum resolving power and resolution coefficient of a roentgenographic film or roentgenoscopic screen will be discussed. Methods for measuring these parameters as well as quantitative data on representative commercial films and screens will be included.

Resolving power is a measure of the ability of a photosensitive material (e.g. photographic film, roentgenographic film, fluorescent screen, etc.) to record detail. It is customarily determined by projecting on the material under test an image of a suitable object whose pattern is relatively difficult to reproduce and whose pattern may be varied in a quantitative manner from a fine to a coarse configuration.

In photography the test-object usually employed is a black and white, high contrast, line drawing similar to that shown in Figure 1, Part 1, of this series. The width of the lines is customarily equal to the width of the spaces although for some work this practice is not always retained. The drawing is photographed on the film under test, care being taken to use a lens capable of resolution considerably better than that of the film. The film usually experiences little difficulty in reproducing the coarser patterns. As one proceeds to the finer con-

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‡ Morgan, R. H. An analysis of the physical factors controlling the diagnostic quality of roentgen images. Part 1. Introduction. AM. J. ROENTGENOL. & RAD. THERAPY, August, 1945, *54*, 128–135.

figurations, however, the patterns eventually become so small that the lines fuse and appear as a homogeneous density. The greatest number of lines per millimeter which can be distinguished in the developed and processed film constitutes the film's resolving power.

The methods of measuring the resolving power of photographic materials have become well standardized. Normally, a high contrast test-object is employed and accordingly the determinations indicate maximum resolving power (see equation (1)). Photographic manuals, listing the resolving powers of various photographic materials, however, usually omit the qualifying term, "maximum," it being taken for granted that the reader recognizes the omission.

Although methods for measuring the resolving powers of photographic materials are well established such is not the case for roentgenographic films and fluorescent screens. The development of a suitable test-object appears to be the principal difficulty which has impeded progress in this direction. It will be obvious that the test-objects which have proved so successful in photography are useless in roentgen applications. It is theoretically possible to construct a test-object composed of alternating laminations of lead foil and of paper (or some other radiolucent material) which when interposed in a roentgen beam will produce on a roentgenographic film or fluorescent screen a linear image similar to those produced by photographic test-objects on photographic film. Furthermore, by varying the thickness of the laminations, the pattern could be varied quantitatively from a fine to a coarse configuration. In practice, however, such test-objects are extremely difficult to construct and use. If they are not precisely aligned with the roentgen beam, the results obtained are unreliable since slight maladjustment of a few minutes of a degree will cause adjacent laminations to overlap in the beam.

Before discussing other attempts to make suitable test-objects for roentgen measurements, it might be well to consider briefly the criteria which must be fulfilled by a standard test-object for use in measuring the resolving power of a photosensitive material. First, the object must present a relatively intricate pattern so that the ability of the material to record detail is adequately tested. Second, it must be possible to vary, quantitatively, the size of its pattern, retaining at the same time an identical configuration; third, the object must be easily reproducible. In addition to these, there are certain other criteria which must be fulfilled for roentgen experiments: Alignment with the roentgen beam must be easily obtained and, other things being equal, measurements must be independent of the quality of the roentgen radiation.

It is evident that although a linear test-object has been found suitable in photography, it is not essential that such a pattern be retained in roentgenography or roentgenoscopy. Realizing this, White[1] recently developed a test-object which when properly designed appears to fulfill all of the above criteria. The object consists of wire ranging in size from 0.08 to 4 mm. in diameter wound on mandrils of convenient diameter (e.g., 2 to 5 mm.). Approximately 10 to 15 turns of each size of wire are employed, and are wound with adjacent turns in close apposition. Eighteen sizes of wire within the limits of diameter stated provide a sufficient number of steps to permit a satisfactorily precise evaluation of the resolving power of any roentgenographic film exposed with intensifying screens and of any roentgenoscopic screen now available. Test-objects with finer wire are now being constructed for the testing of films exposed to roentgen radiation directly. A photograph of a portion of the wire-wound test-object is shown in Figure 1*a*. Figure 1*b* illustrates a roentgenogram of this same segment. It will be observed that the object produces a serrated pattern, a configuration somewhat more difficult to reproduce than the linear photographic pattern.* The prac-

* This is borne out by the fact that the resolving powers of several photographic films measured in this laboratory with a serrated test-object identical in configuration to the silhouette of

tice has been adopted in this laboratory to specify resolving-power measurements made with this test-object in terms of serrations per millimeter, the resolving power of a material being the largest number of serrations per millimeter which can be distinguished.

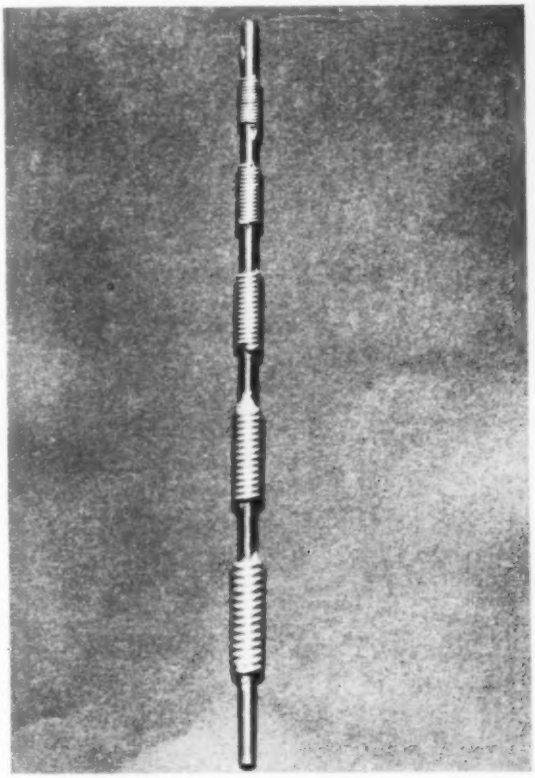

FIG. 1*a*. Wire-wound test-object suitable for measuring the resolving power of roentgen materials.

The wire-wound test-object is easily constructed and simple to align with the roentgen beam. Furthermore, when silver wire is employed, results are independent of roentgen quality over a range extending from a half-value layer of 0.33 mm. Al to a half-value layer of 9.0 mm. Al. This embraces the range of quality usually employed in diagnostic roentgenology. This independence of quality is well shown in

the wire-wound test-object are approximately 30 per cent less than those measured with the conventional line drawing. This relationship was also found to hold for measurements of visual resolution.

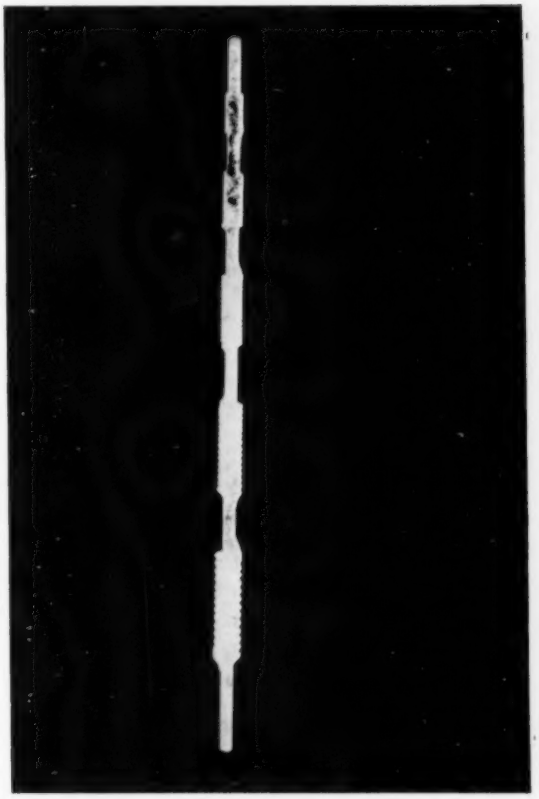

FIG. 1*b*. Roentgenogram of test-object, shown in Figure 1*a*, illustrating serrated pattern.

Figure 2 where the resolving power of Eastman Blue Brand film exposed with a

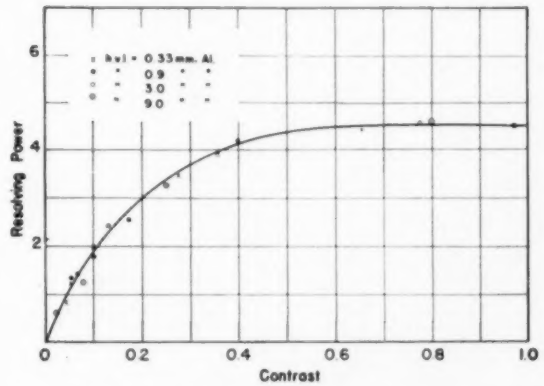

FIG. 2. Relationship between resolving power and contrast for Eastman Blue Brand film exposed with a Buck front type intensifying screen for four qualities of radiation. The manner in which the experimentally observed values fall closely along a common locus indicates that the test-object performance is independent of roentgen quality.

front type Buck intensifying screen is plotted over a wide range of contrast for four qualities of exposing radiation. It will be observed that the various points fall, within experimental error, on a common locus. A front screen only was used in conducting this determination because the resolving power of such a film-screen combination should remain constant regardless of the quality of the exposing radiation. As will be shown presently, the resolving powers of films exposed in the conventional manner with front and back intensifying screens often vary considerably with roentgen quality, principally due to differences in the contribution to film blackening by the dissimilar front and back screens.

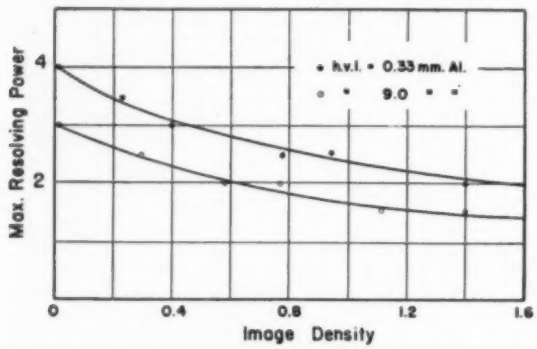

Fig. 3. Maximum resolving power of Eastman Blue Brand film exposed with Buck X-tra Speed intensifying screens plotted as function of image density for two qualities of radiation. Observe how resolution diminishes with increasing image density; also how resolution diminishes with increasing hardness of the radiation. In Buck X-tra Speed screens the front screen is a fine-grain type, the back screen a relatively coarse-grain type. When the radiation is of long wavelength the front screen contributes predominantly to film blackening because little radiation penetrates to the back screen. Consequently resolution is high (fine-grained front screen). When the radiation is of short wavelength much of the film blackening is contributed by the inherently brighter back screen because the radiation now is able to penetrate the front screen. Consequently resolution is low (coarse-grained back screen).

The resolving powers of four brands of roentgenographic film, exposed in combination with nine brands of intensifying screens have been determined with the wire-wound test-object. Two brands of fluoroscopic screens and two photofluorographic assemblies have also been examined. The roentgenographic and photofluorographic exposures were made over an image-background contrast range extending from a density of zero to a density of 2.0, a range more than sufficient with which to evaluate the maximum resolving power of the material under test.

The various determinations were made simply by placing the test-object over the cassette containing the film or film-screen combination under examination and giving sufficient exposure to produce the desired contrast. The experiments were conducted with four qualities of radiation having half-value layers of 0.33, 0.9, 3.0 and 9.0 mm. of aluminum respectively.

Because of the high absorption of the silver test-object, the image density of the various films was essentially zero. Since resolving power might be a function of image density, the determinations were repeated after the film-screen combination had been given sufficient over-all pre-exposure (i.e., with no test-object in place) to produce final image-densities of approximately 0.5, 1.0, 1.5 and 2.0. The many films were processed under as closely identical conditions as possible in a pictol-hydroquinone developer at a temperature of 65° F. and with a developing time of five minutes. The results of these experiments are recorded in Figure 3 and in Tables I and II.

In Figure 3, the maximum resolving power (R_m) of a typical film-screen combination is plotted as a function of image-density for the two extreme qualities of radiation studied. It will be observed that R_m is greatest when the image density is zero and gradually decreases when this parameter increases. All of the films and film-screen combinations studied exhibited this general characteristic, some of the materials demonstrating it slightly more than others. It is also noteworthy that for the particular film-screen combination illustrated in Figure 3, R_m decreases con-

siderably when the quality of the exposing radiation becomes harder. This effect, as one might expect, is always particularly pronounced when exposures are made with front and back intensifying screens that are markedly dissimilar and is absent in photofluorographic films.

In Table I are tabulated the maximum resolving powers of four commercial brands of roentgenographic films exposed with nine types of intensifying screens. The screens marked with a single asterisk are so-called "high speed screens," those marked with a double asterisk, "medium speed screens" and those marked with a triple asterisk, "high definition screens." Data for photofluorographic films are listed in Table II. It will be observed that two figures are listed for the various film-screen combinations. These data indicate the limits of maximum resolving power over the range of quality studied. All of the figures for the roentgenographic materials were determined from films having an image density of zero; approximate values at other image densities may be calculated with little difficulty from Figure 3.

TABLE I

MAXIMUM RESOLVING POWERS (SERRATIONS PER MILLIMETER) OF VARIOUS FILM-SCREEN COMBINATIONS NOW COMMERCIALLY AVAILABLE IN THE UNITED STATES

Brand of Intensifying Screen	Brand of Film			
	A	B	C	D
I*	3.0 2.5	3.0 2.5	3.0 2.5	3.0 2.5
II**	4.0 3.5	4.0 3.5	4.0 3.5	4.0 3.5
III***	6.0 6.0	6.0 6.0	6.0 6.0	6.0 6.0
IV*	4.0 3.0	4.0 3.0	4.0 3.0	4.0 3.0
V**	4.0 3.5	4.0 3.5	4.0 3.5	4.0 3.5
VI***	5.0 5.0	5.0 5.0	5.0 5.0	5.0 5.0
VII*	3.5 3.0	3.5 3.0	3.5 3.0	3.5 3.0
VIII**	4.0 3.5	4.0 3.5	4.0 3.5	4.0 3.5
IX***	4.0 3.5	4.0 3.5	4.0 3.5	4.0 3.5

* "High speed screens."
** "Medium speed screens."
*** "High definition screens."

TABLE II

MAXIMUM RESOLVING POWERS (SERRATIONS PER MILLIMETER) OF VARIOUS PHOTOFLUOROGRAPHIC FILMS

Film	Resolving Power
35 mm.	0.75
70 mm.	1.25
4×5 inch	1.50

Eastman Photofluorographic film (an orthochromatic or blue, green and yellow sensitive emulsion) was used for the 35 mm. and 70 mm. exposures. Single coated Eastman Blue Brand film (blue sensitive emulsion) was used for the 4×5 inch exposure.

Attention is directed to the independence of resolving power and the brand of roentgenographic film. Apparently the resolution of an intensifying screen is so much lower than that of a film that the resolving power of the latter plays very little part in determining the resolution of the film-screen combination.

The experiments on the fluorescent screens (type "B" and photoroentgen) were performed by making contact exposures with photofluorographic film. They have no direct significance relative to what may be seen with these screens roentgenoscopically, but are useful, as will be shown presently, in studying certain problems in photofluorography. Visual data on roentgenoscopic screens are now in preparation and will be reported in a later communication.

The resolving power of a photosensitive material is a function of several factors including the sharpness with which an image is recorded and the granularity of the film. Lowry[2] and Goetz, Gould and Dember[3]

have shown that granularity increases with film-density. In Part VI of this series it will be shown that sharpness decreases with film-density. In view of these facts it is not surprising that resolving power also decreases with film-density.

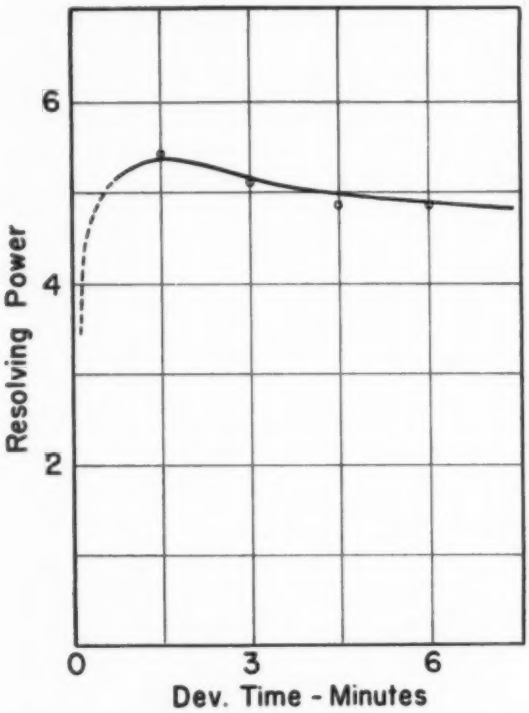

FIG. 4. Relationship between resolving power and developing time for a typical roentgenographic film-screen combination.

There is considerable experimental evidence to indicate that maximum resolving power is influenced by the process of development. Sandvik[4] and Ronchi[5] found that as development progresses, resolving power rises rapidly to a maximum, diminishes somewhat, and then remains essentially constant. This characteristic appears to be common to most photographic emulsions. Several roentgenographic films and film-screen combinations have been examined in this laboratory to determine the effect of development on resolution. The relationship between resolving power and time of development for a typical roentgenographic film-screen combination is shown in Figure 4. The curve is similar in configuration to those obtained by Sandvik and Ronchi. It should be pointed out here that although maximum resolving power does not change appreciably after a short development, the inherent contrast factor of a film rises rapidly as development progresses. The observed resolving power for images of low contrast, as indicated by equation (1b), therefore diminishes rapidly with underdevelopment.

At one time, developer composition was thought to have a marked effect on resolving power. Experiments by Ross,[6] however, do not seem to justify this opinion. The influence of developer composition on the resolution of roentgenographic materials was not thoroughly studied in this investigation, but some evidence was obtained which tends to indicate that resolution is not greatly affected by developing parameters.

The data for the photofluorographic materials listed in Table II require further discussion. These values do not represent the maximum number of serrations per millimeter of film that can be visualized but, instead, indicate the maximum number of serrations per millimeter observed when the film is enlarged or magnified to a point where the image of the test-object appearing in the photofluorogram is identical in size to the object itself. This method of notation was adopted so that the photofluorographic and roentgenographic data might be comparable. The maximum resolving powers of 35 mm., 70 mm., and 4×5 inch photofluorograms, measured in the conventional way, are 9.0, 7.5 and 5.25 serrations per millimeter respectively. Since the images appearing in the several films constitute minifications of approximately 12.5, 6.25 and 3.7 times respectively, the effective resolving powers fall to the values appearing in Table II.

It is evident that the effective resolving powers of photofluorographic materials are rather low. The cause of this phenomenon can be attributed to a number of factors. It was pointed out in Part I of this series that resolving power may be markedly re-

duced when conditions which promote unsharpness of the roentgenographic images are present. In photofluorography, three such conditions exist. Some unsharpness is produced by the fluorescent screen; more is contributed by the lens of the photofluorographic camera and finally the clarity of the image is further reduced by the inherent unsharpness of the film. In general, when several factors which produce unsharpness operate collectively, the overall or total unsharpness is the sum of the individual factors;* that is,

$$U_t = U_1 + U_2 + \cdots U_n \qquad (2)$$

Since resolving power tends to bear an inverse relationships to unsharpness (equation (12), Part I), the resolving power of the photofluorographic process may be expected to approximate

$$\frac{1}{R_{pf}} = \frac{1}{R_s} + \frac{1}{R_e} + \frac{1}{R_f} \qquad (3)$$

where R_{pf} is the resolving power of the photofluorographic process;
R_s is the resolving power of the fluorescent screen;
R_e is the resolving power of the lens, and
R_f is the inherent resolving power of the photofluorographic film.

The resolving power of the fluorescent screens customarily employed in photofluorography is 2.25 serrations per millimeter. The resolving powers of conventional photofluorographic lenses and film are each approximately 50 lines per millimeter or 35 serrations per millimeter. Values of lens and film resolution, however, cannot be considered in relation to that of the screen until account is taken of the amount of magnification necessary to enlarge the film to screen size. With such enlargement, the resolving powers for lenses and films become 3.0, 6.0 and 10 serrations per millimeter for 35 mm., 70 mm. and 4×5 inch films respectively. Substituting these values in equation (3) the predicted resolving powers of the various photofluorographic processes are 0.9 ser./mm. (35 mm. film); 1.25 ser./mm. (70 mm. film); and 1.5 ser./mm. (4×5 inch film). It is interesting that the predicted values fall close to the observed values listed in Table II.

It is noteworthy that in the case of 35 mm. photofluorography the values of the various factors in equation (3) are closely similar. Accordingly, although some increase in resolving power could be achieved by improving the characteristics of either the screen, lens or film, such an increase would not be great until all three were appreciably improved. It is not likely, therefore, that any significant increase in the resolution of 35 mm. photofluorograms will occur for some time. In the case of 70 mm. and 4×5 inch photofluorography, however, the resolution of the screen is considerably below that of the lens and that of the film. Thus, although no large increase in resolving power could be realized by improving the latter two components, a sizable increase could be accomplished by improving the properties of the former. Indeed, by doubling screen resolution, the resolving powers of 70 mm. and 4×5 inch photofluorograms would be raised to 1.8 and 2.3 ser./mm. respectively; that is, increases of 50 per cent and over. It is not known what possibilities exist for improving photofluorographic screens. However, efforts to enhance the quality of 70 mm. and 4×5 inch photofluorograms should be centered on this phase of the problem.

Finally, let us direct our attention to a discussion of the resolution coefficient, *a*, a factor which plays an important rôle in determining the resolving power of roentgen images at low contrast levels. Referring to equation (1a) it is evident that *a* may be determined by measuring the slope (R/C) of the resolving power versus contrast curve at zero contrast and dividing the result by the value of the film's maximum resolving power, R_m. Values of *a* for present-day roentgen materials fall within a rela-

* This relationship is valid only under limited circumstances. It will be discussed at considerable length in Part VI of this series.

tively narrow range in the vicinity of 5.0. They appear to be independent of the quality of the exposing radiation and are only slightly affected by the density of the roentgenographic image.

Little is known regarding the factors which govern the resolution coefficient of a photosensitive material. Since it achieves its principal significance at low contrast levels, it is possible that its value is a function of the grain-size distribution of the particles which comprise the material and of the statistical fluctuation in the intensity of the exposing radiation. It is interesting that when visual resolution is tested, values of a, exceeding 9.5 have been obtained under conditions of maximum visual acuity. Sandvik[4] when testing several photographic materials obtained values of approximately 2.2, on the other hand. A great deal more must be known of the fundamental relationships between resolution and contrast before the significance of the resolution coefficient can be fully understood. This of course need not lessen the usefulness of experimentally derived values of the coefficient in the prediction of the resolution of roentgenographic films and roentgenoscopic screens at various contrast levels.

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NOTES ON THE USE OF PROTECTIVE GLASS IN PHOTOFLUOROGRAPHIC EQUIPMENT*

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IT HAS been standard practice in the construction of photofluorographic equipment to place a sheet of plate or lead glass† between the fluorescent screen and the photographic camera. Dust, thereby, is prevented from falling on the screen and, in the case of lead glass, the photographic lens and film magazine are protected from excessive radiation exposure. Conventionally, the glass is placed either in direct contact with the screen, thereby providing some support to this structure, or an inch or two toward the photographic camera. A schematic diagram of the latter arrangement is shown in Figure 1.

Although a number of worth while purposes is served by the glass, its use is attended by several disadvantages. First, it complicates the optical system between the screen and photofluorographic film, thereby causing some reduction in the clarity or detail with which the various fluorescent images are recorded. Furthermore, it reflects a portion of the light emitted by the screen. This reflected light is diffusely distributed over the screen surface, thereby fogging the images appearing therein and reducing their contrast. In addition, the glass adds materially to the weight of the photofluorograph, is relatively fragile and therefore subject to damage under the rigorous operating conditions of photofluorography and, finally, reduces the intensity of the light reaching the photographic camera and accordingly prolongs the roentgen exposure to some degree.

The extent to which the disadvantages of the glass counteract the benefits has been the cause of much speculation in recent years. The matter has been currently under investigation in this laboratory and it is hoped that the results obtained will provide a satisfactory answer to the question.

The effect of the protective glass on the clarity or detail with which photofluorographic images are recorded was studied by measuring the resolving power of photofluorographic film in the presence and in the absence of the glass. These measurements were carried out by photofluorographing on the film under test a wire-wound test-object similar to that recently described by one of the authors.[1,2] This object produces on the film a series of serrated patterns ranging from a fine to a coarse configuration. In 35 mm. photofluorography the film was able to resolve 0.75 serration per millimeter when the glass was present and 1.0 serration per millimeter when it was absent. Thus the removal of the glass improved the clarity of reproduction by 33 per cent. In 70 mm. photofluorography the results were less

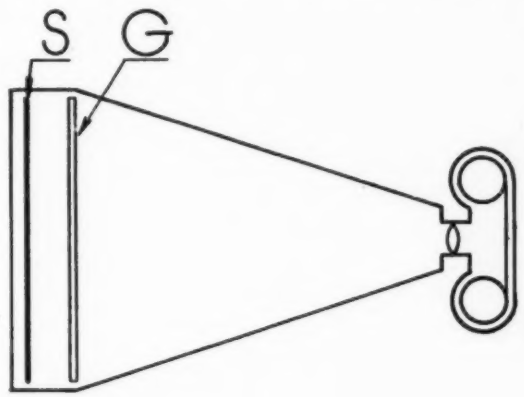

FIG. 1. Schematic diagram of typical photofluorograph illustrating relationship of fluorescent screen, *S*, and protective glass, *G*.

* From the Radiology Section, Tuberculosis Control Division, U. S. Public Health Service.

† Plate glass is used in the General Electric Photo-Roentgen unit, lead glass in the Westinghouse Photofluorographic unit.

striking. In the presence of the glass, the resolution was 1.25 serrations per millimeter and in its absence, 1.37 serrations per millimeter, or a difference of 10 per cent. The relatively small effect in this instance is likely due to the fact that the influence of the optical system on clarity of reproduction is not as great in 70 mm. as in 35 mm. photofluorography.[2] For similar reasons the difference is also probably small in 4×5 inch photoroentgenography.

The effect of protective glass on the contrast of photofluorographic images may be directly ascribed to reflectance. Some of the fluorescent light radiated by the screen is reflected by the glass and distributed over the screen surface in such a way as to produce a fogging of the included images. The effect is particularly severe when the glass is located some distance from the screen for under this circumstance the radiation is more widely dispersed than when the glass is in contact with the fluorescent material. Furthermore, since reflection occurs at both surfaces of the glass, the reflectance is effectively twice as great when glass and screen are separated as when in contact, for in the latter instance light reflected at the surface in apposition with the screen merely returns to the various crystals from which it originated and is not distributed in a manner which would lead to a reduction in contrast.

The relationship between reflectance and contrast is a simple one. The contrast of a fluorescent image is equal to the difference between the logarithm of the screen brightness at the locus of the image and the logarithm of the screen brightness in the surrounding field. Therefore, if I_i and I_b are the screen brightnesses induced by roentgen radiation in the image and in the surround respectively, the contrast in the absence of reflection is

$$C = \log I_i - \log I_b \qquad (1)$$

Now, if extraneous light such as that reflected from a sheet of protective glass were to fall on the screen, the brightnesses of the image and of the surround would be increased and the contrast changed to a value given by the equation

$$C = \log (I_i + I_r) - \log (I_i + I_r) \qquad (2)$$

where I_r is the intensity of the reflected light falling on the screen.

The values of the several factors appearing in equations (1) and (2) are dependent on a variety of factors including the location of the protective glass. When screen and glass are separated a distance of 2 inches, photometric measurements indicate that the intensity of the reflected radiation returning to the screen is approximately 4 per cent of the brightest significant chest image when the subject under examination covers the entire screen. It is higher when small individuals are photofluorographed due to the high intensity of the light emitted from the uncovered portions of the screen. When this datum is substituted in equations (1) and (2), the loss in contrast suffered by a low contrast fluorescent image of any brightness level less than that of the brightest significant image within the chest silhouette may be easily calculated. This relationship between loss of contrast and screen brightness is illustrated graphically in Figure 2.

It is evident that images of low light intensity such as those of the hilar regions of the chest and of many parenchymal pathological processes* suffer a loss in contrast approaching 20 to 25 per cent. Although this is relatively small it is nevertheless undesirable.

When the protective glass is in contact with the screen, the reflectance cannot be specified so easily as in the case when the two structures are separated. Since the apposition of screen and glass prevents wide diffusion of the reflected light the reflectance varies from point to point over the screen surface. Its nominal value at any location is 4 to 5 per cent of the screen brightness induced by roentgen radiation at that location. Occasionally when a

* The brightness of the screen within the images of the hilar regions is usually 10 to 20 per cent of the brightness of the midlung fields.

series of small low intensity images is located in a bright surround the ratio of reflectance to image intensity rises to rather high levels. Since this situation occurs infrequently, however, the loss in contrast when glass and screen are in contact is usually not greater than 5 to 10 per cent.

The increase in roentgen exposure observed when a sheet of glass is placed between the fluorescent screen and photographic camera is caused by a part of the light emitted from the screen being absorbed or reflected by the glass and thereby prevented from reaching the camera. The effect is mainly one of absorption, only a small portion of the reflected light being lost since most of it returns to the screen where it is redirected toward the camera.

In one photofluorograph that was studied in this laboratory it was necessary to increase the roentgen exposure 8 per cent* when lead glass 0.25 inch in thickness was placed between the fluorescent screen and photographic camera. Undoubtedly there are samples of such glass where a greater increase is necessary. When plate glass was investigated the absorption was so minimal that no increase in exposure was required.

From the foregoing it is evident that the disadvantages of protective glass in photofluorographic equipment depend on the construction and type of apparatus. A significant loss of clarity is observed in 35 mm. film. Loss of contrast is especially pronounced when the protective glass and screen are separated. When lead glass is employed an increase in roentgen exposure is necessary to compensate for the light absorbed by the glass.

The benefits derived from the use of protective glass are, as previously pointed out, the prevention of damage to the fluorescent screen by dust and accident and, in the case of lead glass, the protection of the photographic lens and film magazine from excessive radiation exposure. In regard to the effect of roentgen radiation on the photographic lens, it is known that large quantities of radiation discolor the glass and reduce its transmission. Furthermore, instances have been reported[3] where the cementing materials of the lens have become cloudy, thereby seriously affecting lens performance. These effects, however, have been observed only under unusual circumstances and there is considerable doubt that changes would occur under photofluorographic conditions in the absence of protection.

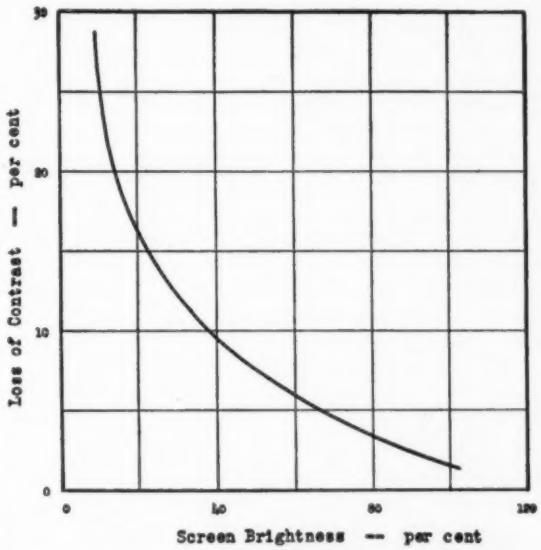

FIG. 2. Loss of contrast suffered by fluorescent images of various brightness levels as a result of reflection from a sheet of protective glass located 2 inches in front of a photofluorograph's fluorescent screen. One hundred per cent brightness level corresponds to the illumination of the brightest significant image within the chest silhouette. Data are based on an average reflectance of 4 per cent of the 100 per cent brightness level, a value consistent with experimental observation.

Radiation measurements conducted in this laboratory on a photofluorograph from which the lead glass had been removed revealed that under average conditions (i.e., a subject 20 cm. in thickness photofluorographed with the roentgen machine operating at 90 kv. (peak) and 200 ma. and with

* A perusal of the literature reveals a relatively wide variation in the absorption data for lead glass. This situation is probably the result of differences in the characteristics of the lead glass studied and failure of some workers to separate the effects of absorption and reflectance.

an exposure time of 0.2 sec.) 0.001 r per exposure is received at the lens site. Since the normal life of a photofluorograph is approximately 500,000 exposures, an unprotected lens, therefore, may be expected to receive 500 r over its period of service. Following these measurements an Eastman Ektar lens similar to those employed in 35 mm. and 70 mm. photofluorography was subjected to a series of graded exposures totalling over 1,000 r. No evidence of lens discoloration or clouding occurred and determinations of relative lens speed (reciprocal of the exposure required to produce a film density of 1.5) made during the test revealed no loss of transmission. In Figure 3, these determinations are plotted against the number of equivalent exposures received by the lens, one equivalent exposure equalling 0.001 r. In these experiments the quality of the roentgen radiation employed was identical to that encountered in photofluorographic practice (half-value layer = 6 mm. of aluminum). It is evident that protection of the photographic lens is quite unnecessary.

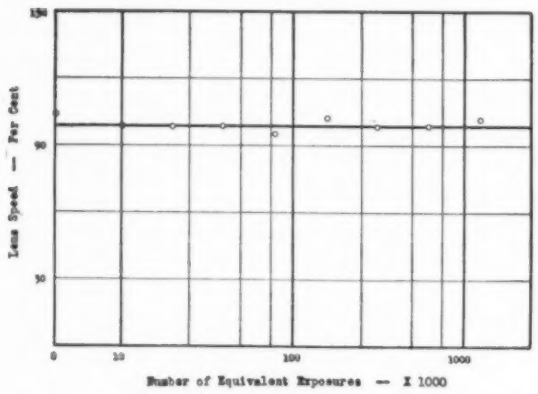

FIG. 3. Speed of an Eastman Ektar f/1.5 lens plotted as a function of the number of equivalent exposures to which the lens was subjected in test to determine effect of exposure to roentgen radiation. One equivalent exposure was 0.001 r, the radiation to which the lens would be subjected in a photofluorograph without lead glass protection during the exposure of an average photofluorogram.

In regard to the film magazine, protection is particularly important when a roll-film camera is employed. In 35 mm. photofluorography over 700 exposures and in 70 mm. photofluorography over 350 exposures are normally made on a 100 foot roll and the film magazine is therefore subjected to 0.70 r and 0.35 r respectively during the time these exposures are made if no protection is provided. Such a quantity of radiation is sufficient to cause considerable fogging of the film. Although adequate protection may be obtained by the use of lead glass placed between the fluorescent screen and photographic camera it may be achieved equally well by lining the film magazine with lead foil.

The need for protection of the photofluorographic screen against dust and accident does not appear to be very striking. Although present-day screens are of such construction that they are rather susceptible to damage, experience indicates that under normal photofluorographic conditions screens are seldom impaired accidentally even in the absence of protective glass. Furthermore, screens are now under development which are similar in design to intensifying screens in that they are covered by a thin transparent acetate film and therefore require no other protection.

From the foregoing it is clear that the benefits accruing from the use of protective glass are either non-existent or may be obtained equally well by other means. In view of the disadvantages of the glass it seems wise to dispense with it and in so doing take advantage of the increased clarity of reproduction and contrast that will consequently occur.

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3. Long, H. F. A. Personal communication.

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Twenty-eighth Annual Meeting: 1945, canceled.

EDITORIALS

THE TREATMENT OF LATE IRRADIATION ULCERS BY RADON IMPREGNATED VASELINE OINTMENT

IN NEARLY all radiotherapeutic departments a certain number of late irradiation injuries are observed which, from the point of view of management and treatment, often present a most difficult problem. They may be grouped into several categories. In some, an indolent ulcer develops within a heavily irradiated, although not overdosed area, many years after treatment was given with the customary technique for a common, as a rule malignant, neoplasm. In others, the ulceration is the result of a breaking down of an atrophic telangiectatic skin induced by an excessive irradiation of a harmless dermatologic condition. In still others, the injury is the end product of small repeated exposures over a long period of time during the course of professional work. Finally, with the advent of increasing use of the roentgen rays and radium in industry, not a few injuries are observed in technical workers who either through lack of sufficient protection or because of their own carelessness, are subjected to relatively large amounts of radiation.

There are many remedies recommended for the treatment of such late irradiation injuries. Their various indications and respective therapeutic values are well known and need not be expounded here. The fact remains that in the presence of a necrosing ulcer situated in a bed of over-irradiated skin or mucosa, many months or years are necessary before anything resembling a healing is accomplished. Often, radical surgical extirpation of the entire affected area constitutes the only method of approach left available.

In 1928 Uhlmann[1] began to use radon, absorbed in vaseline, for the treatment of persistent necrotic ulcers due to excessive irradiation. While the opinion seemed to prevail that an injurious effect produced by roentgen rays or radium could only be made worse by additional administration of the same agents, it was Uhlmann's idea that the alpha rays of the radon, if properly captivated, might lead to a beneficial action, mainly through influence on the blood vessels. According to most investigators, the cause of the late irradiation ulcers must be sought in the impaired blood supply incident to overexposure. Whether this damage is initiated by the selective destruction of the endothelial cells of the capillaries or results secondarily from the destruction of the nerves of the capillary walls, the destruction of the capillary system has a far-reaching effect on the future fate of the area so involved. Once a breaking down of the poorly vascularized tissues has set in, the main purpose of any treatment must consist in the restoration, if possible, of the blood circulation. Ordinary methods, while at times successful in the individual case, cannot be expected to lead to such an effect in general. Uhlmann demonstrated by histologic sections that vaseline, if applied to the skin under proper dressing, penetrates into the deeper layers of the cutis. Since, according to Strassburger's experiments, vaseline absorbs nine times as much radon as a similar volume of air and thirty-six times as much as water at room temperature, it is possible with the aid of such a vehicle, to make the alpha rays reach the capillary system in a relatively high con-

[1] Uhlmann, E. Treatment of injuries produced by roentgen rays and radioactive substances. Am. J. Roentgenol. & Rad. Therapy, 1939, *41*, 80–90; also, Significance and management of radiation injuries. *Radiology*, 1942, *38*, 445–452.

centration. Although the radon during its process of decay also emits beta and gamma rays, the latter produce an ionization density no more than one one-hundredth of that of the alpha rays. It is assumed that this heavy bombardment of the tissues by the alpha particles leads to increased local capillary blood supply followed by a complete re-epithelization of the ulcer.

Based on such theoretical considerations, Uhlmann made a preparation by charging white or yellow petrolatum with radon in a concentration of about 100 electrostatic units per gram of vaseline, 1 electrostatic unit being equal to 0.000364 millicurie-destroyed. This concentration is quite weak so that it would take twenty times as much to produce an erythema in one seance. Since the radon decays at the rate of 16.5 per cent of its strength every twenty-four hours it is necessary that the ointment be prepared fresh before use, or if applied at a later date, that the proper dosage calculations be made to bring the intensity value up to that intended on the day of use. Exponential decay curves similar to those used with ordinary radon seed therapy will serve a good purpose in this connection.

The mode of application, as advocated by Uhlmann, is very simple. The ointment is spread with a spatula over the ulcer and immediately covered with a piece of rubber dam or oilcloth to prevent evaporation of the radon. The covering is fastened to the skin with overlapping adhesive strips. The duration of the application is, on an average, eight hours, after which the dressing is removed by the patient. The treatment is repeated two to ten times at weekly intervals, although in a few of the more severe cases as many as twenty treatments are required. The ulcer and surrounding skin are covered with a 10 per cent boric-beryllium ointment in the interval between the radon applications. In a series of 70 cases so treated very encouraging results were obtained.

Later, Kohn-Richards[2] introduced a semi-automatic pump for the preparation of the radon ointment, and made other innovations designed to increase the absorption of radon in vaseline or other media.

In a further study of the subject, Uhlmann and Grossman,[3] reviewing all the cases treated, found that the radon ointment proved so satisfactory in promoting granulation and epithelization in irradiation ulcers that when no healing occurred they were able to postulate and ultimately confirm that a malignant degeneration had taken place. The concentration of the radon ointment, as already stated, is too low to have any effect on a malignant neoplasm. Therefore, such a lesion, in contradistinction to the simple necrotic ulcer, continued to remain clinically active, despite the application of the radon ointment. So uniform was this observation, that Uhlmann and Grossman thought they could use it as a therapeutic test in differentiating between late irradiation necrosis and recurrent cancer.

Recently Cooper and Robertson[4] have published their favorable experience with the radon impregnated vaseline ointment at the Brisbane General Hospital. They have used the method since early in 1943 and obtained good results in all cases except those due to gross over-irradiation.

Cooper and Robertson prepare their ointment by breaking up ordinary radon seeds, used for routine radon moulds, in a jar of hot vaseline. After the jar has stood for twenty-four hours mixing is performed by melting and shaking, until a uniformity of distribution is obtained as evidenced by even fluorescence in the dark. The strength of the ointment is determined by measuring the gamma-ray emission of the whole jar before use.

The mode of application is along the same lines as that employed by Uhlmann.

[2] Kohn-Richards, H. Semi-authomatic vacuum double chamber for absorption of radon in fluid media. Am. J. Roentgenol. & Rad Therapy, 1942, *47*, 636–639.

[3] Uhlmann, E., and Grossman, A. Use of radon ointment as a means of differentiation between radiohecrosis and recurrent carcinoma. Am. J. Roentgenol. & Rad. Therapy, 1942, *47*, 620–623.

[4] Cooper, A.G.S., and Robertson, D.F. Treatment of post-irradiational ulcers by radon ointment. *Med. J. Australia*, 1945, *1*, 297–300.

The thickness of the ointment layer is immaterial since the alpha particles have a range which in the vaseline amounts to only a fraction of a millimeter, but a layer which is at least two to three millimeters thick guards better against loss of the radon. The concentration of the ointment varies from 0.024 to 0.060 millicurie per gram of vaseline. To enhance the tissue absorption of the ointment, the addition of 10 per cent lanolin is very effective. It is also advisable, especially in the painful cases, to interchange during the interim periods the dressings of unguentum acidi borici (10 per cent) with dressings of unguentum olei morrhuae with vaseline.

Cooper and Robertson have tried applications of from five to twenty-four hours at weekly and bi-weekly intervals but, like Uhlmann, gained the impression that an application of eight hours repeated once a week constituted the most desirable procedure. In the case of small ulcers the function of the ointment is to initiate healing, hence a very few applications are sufficient. In the larger ulcers weekly applications over a longer period of time may be necessary. If an ulcer is not considerably improved or reduced in size after four weeks, the presence of a malignant lesion is suspected.

The experience of Cooper and Robertson extends to a series of 69 cases. Of these, 20 proved to be recurrences of the original malignant lesion, 41 have been completely healed with a healthy epithelium and the remaining 8 have been improved to the extent that they can no longer be suspected of being malignant. Thus, in the entire series there is not one single case of an uncomplicated irradiation ulcer which has failed to respond to the treatment.

Stimulated by such splendid results, Cooper and Robertson also treated 15 recalcitrant varicose ulcers observed in 7 patients and 3 chronic ulcers occurring in scars following burns and surgery. Of the varicose ulcers, 9 healed promptly, 5 improved and only 1 failed to respond. The 3 ulcers of scars following burns and surgery healed completely without the addition of any other type of treatment.

Obviously, it is too early to assess the permanency of these results. For the present, it appears that ulcers which have healed continue to remain healed. It is the opinion of Uhlmann, and of Cooper and Robertson that the use of radon impregnated vaseline ointment constitutes a therapeutic method full of promise, not only in persistent late irradiation ulcers but also in certain other recalcitrant ulcers of various etiology.

T. Leucutia

Courtesy General Electric X-Ray Corp.

GLENN W. FILES
1897-1945

Glenn W. Files, director of the Technical Service Department of General Electric X-Ray Corporation since 1934, and an employee of the company for twenty-six years, died at the Alexian Brothers Hospital, Chicago, on September 11, 1945, at the age of forty-eight, following a heart attack. He resided at 2117-78th Ave., Elmwood Park, Illinois.

Born January 17, 1897, in Winfield, Kansas, Files began roentgen-ray work as a technician for a physician in that com-

munity, later meeting and working there with Dr. E. C. Jerman. In World War I, he was a sergeant in the Army, serving in France as an x-ray instructor and technician.

Files joined Victor X-Ray Corporation, predecessor of General Electric X-Ray Corporation, August 26, 1919, as an instructor under Dr. Jerman, director of the Education Department, and he became director following Dr. Jerman's retirement.

Widely acclaimed by the medical profession for his contributions to the development of roentgenologic technique and instruction methods, Files was the editor of the well known book, "Modern Radiographic Technic," published in 1943, of which 15,000 copies have been distributed. Files was editor-in-chief of "X-Ray Studies III," published in 1935, and he assisted in the publication of "Modern X-Ray Technic" in 1928, and "X-Ray Studies and Advanced Radiographic Technic" in 1931, edited by Dr. Jerman.

In addition, articles by Files appeared in the *X-Ray Technician* and the American Journal of Roentgenology and Radium Therapy, and for a time he contributed a column on x-ray technic to *Victor News*.

He was a member of the General Electric X-Ray Quarter Century Club; a member of the American Society of X-Ray Technicians, which he helped found; a member of the General Electric X-Ray Post of the American Legion; and he belonged to the Lakeview Lodge of A.F. and A.M.

He is survived by his wife, Alison, and by a brother Lennis of San Francisco.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: 1945, canceled.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: 1945, canceled.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1945, to be announced.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION
Secretary, Dr. Gordon G. King, 3700 California St., San Francisco 18, Calif.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION
Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 P.M. at Allerton Hotel on fourth Monday each month, October to April, inclusive.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 P.M.

DENVER RADIOLOGICAL CLUB
Secretary, Dr. A. Page Jackson, Jr., 1612 Tremont Place, Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Acting Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meets annually second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY
Secretary, Dr. Richard C. Batt, Berlin, N. H. Four meetings a year.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY
Secretary, Dr. Major Fleming, Rocky Mount, N. C. An-

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

nual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

NORTH DAKOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

PACIFIC ROENTGEN SOCIETY
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. C. L. Stewart, Jefferson Hospital, Meetings first Thursday of each month, October to May, at at 8:00 P.M., in Thomson Hall, College of Physicians, 21 S. 22d St.

PITTSBURGH ROENTGEN SOCIETY
Secretary, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets 6:30 P.M. at The Ruskin on second Wednesday, each month, October to May inclusive.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY
Secretary Dr. A.M. Popma, 220 N. First St., Boise, Idaho.

ST. LOUIS SOCIETY OF RADIOLOGISTS
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

SAN DIEGO ROENTGEN SOCIETY
Secretary, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.

SAN FRANCISCO RADIOLOGICAL SOCIETY
Secretary, Dr. Carlton L. Ould, University of California Hospital, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

SHREVEPORT RADIOLOGICAL CLUB
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, Jan. 17, 1945.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

VIRGINIA RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

FACULTY OF RADIOLOGISTS
Secretary, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

CANADIAN ASSOCIATION OF RADIOLOGISTS
Secretary, Dr. J. W. McKay, 1620 Cedar Ave., Montreal P. Q.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

SOUTH AMERICA

SOCIEDAD ARGENTINA DE RADIOLOGIA
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDAD PERUANA DE RADIOLOGIA
Secretary, Dr. Victor Giannoni, Apartado, 2306, Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión, Villalta 218, Lima.

CONTINENTAL EUROPE

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SECOND INTER-AMERICAN CONGRESS OF RADIOLOGY

In the April, 1945, issue of the JOURNAL a preliminary announcement was made of the Second Inter-American Congress of Radiology which was planned at that time to be held in Havana, Cuba, January 19–24 1946. Since that announcement was made it has been decided, for a number of reasons that it was best to postpone the Congress and the dates now chosen are November 17–22, 1946. A more extended notice appears in advertising page xvii of the September issue of the JOURNAL. The place of the meeting is still to be Havana and the President of the Congress is Dr. Pedro L. Fariñas. Inquiries for further information should be addressed to the Secretary-General, Dr. R. Hernandez Beguerie, Calle 23, No. 411, Vedado, Havana, Cuba.

REPRINTS WANTED BY FRENCH RADIOLOGISTS

In a communication recently received from Dr. Robert Coliez, Vice-President of the Association of French Radiologists, the radiologists of France send their greetings to their colleagues in the United States after the long years of war. Having received practically no scientific papers on radiology from the United States during these years, they are anxious that American radiologists send reprints of articles on the following subjects which have appeared since 1939: (1) diagnostic roentgenology; (2) roentgen therapy; (3) radium therapy and neutron therapy; (4) electrology; (5) cancerology; also progress in apparatus and techniques, clinical results, and so forth, between 1939 and 1945. Reprints should be sent to Docteur Robert Coliez, 25, Rue Franklin, Paris, XVI^{eme}, France.

CANCER TEACHING DAYS

A Cancer Teaching Day was held in Middletown, New York, on September 18, 1945, under the auspices of various county and state medical societies. The speakers on the program and their subjects were as follows: "Cancer of the Skin and Allied Tumors" by Dr. Earl D. Osborne, Buffalo, New York; "Cancer of the Uterus and Vagina" by Dr. Arthur J. Wallingford, Albany, New York; "Diagnosis and Curability of Intraoral Cancer" by Dr. Hayes Martin, New York; "Cancer of the Breast" by Dr. Cushman D. Haagensen, New York; "Cancer of the Colon and Rectum" by Dr. George E. Binkley, New York.

On October 9 an evening meeting was held in Rochester, New York, at which the following two papers were given: "Carcinoma of the Colon" by Dr. John H. Garlock, New York; "Progress in Cancer Research" by Dr. John J. Morton, Jr., Rochester, New York.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

RADIATION AND CLIMATIC THERAPY OF CHRONIC PULMONARY DISEASES: WITH SPECIAL REFERENCE TO NATURAL AND ARTIFICIAL HELIOTHERAPY, X-RAY THERAPY, AND CLIMATIC THERAPY OF CHRONIC PULMONARY DISEASES AND ALL FORMS OF TUBERCULOSIS. Edited by Edgar Mayer, M.D., F.A.C.P., F.A.C.C.P., Assistant Professor of Clinical Medicine, Cornell University Medical College, New York City; Attending Physician New York and Memorial Hospitals; Special Pulmonary Consultant, New York State Department of Labor, etc., with the collaboration of 22 other contributors. Cloth. Price, $5.00. Pp. 393, with numerous illustrations. Baltimore, Maryland: Williams & Wilkins Company, 1944.

This book is a compilation of the uses of natural and artificial light, of solar radiation, climatotherapy and roentgen therapy in a number of diseases. An editor and twenty-two collaborators express their ideas on the treatment of chronic diseases of the lungs, including tuberculosis, and of all extrapulmonary tuberculosis.

The book presents in brief summary and elementary form the physics of light radiation, the physiological action and clinical effect of light from selected portions of the spectrum on the skin, blood, on the healing of wounds, on bacteria, and so forth. It advocates the discriminate use of artificial light in pulmonary tuberculosis if the disease is fibrous but not when it is exudative. Light treatment appears to ease pain and other symptoms in nonpulmonary tuberculosis and hastens healing of postoperative sinuses. It is stated that in urogenital tuberculosis "about fifty patients have been treated [by the author] with the bladder lamp and about half of these have been benefited."

The book expresses the belief that climate exerts a subtle but profound effect on the human body in health and disease. As proof, people in the tropics having "a sluggish combustion rate" tend to succumb more to infectious diseases and among those in the cooler zones more die of degenerative disease. People planning to migrate because of tuberculosis are advised to avoid stormy and moist climates.

Under treatment by roentgen rays several authors discuss irradiation of intrathoracic tumors, treatment of nontuberculous diseases of the lungs and of tuberculosis of the several parts of the body. They present a variety of opinion most of which favors employment of this mode of therapy. Data given on roentgen treatment of tuberculous cervical adenitis indicate a high percentage of healing in that 225 out of 250 cases appear to have been cured or markedly improved. In pelvic tuberculosis roentgen irradiation yielded better results than operation. In pulmonary tuberculosis one author after commenting on the diversity of opinions as expressed by various workers in the field reports "in the face of the comments it is hard to decide whether to risk a clinical test of the action of x-rays in tuberculosis or to abide by the statements of others and eliminate this lesion from consideration in the realm of roentgen treatment." The editor's footnote at this point indicates his belief that roentgen therapy for tuberculosis of the lungs is not a satisfactory form of treatment.

Tuberculosis of bones and joints comes in for its share of discussion and treatment under the title of surgical vs. conservative therapy. It is concluded by one author that surgical treatment is quicker in producing results and with fewer instances of recurrence. Another author expresses the belief that the eventual results are better from conservative management.

The editor is a well known leader in his field as are many of the collaborators but the reader cannot but wish in many portions of the book that more controlled clinical data had been presented to support the clinical impressions advanced. The overall message of the book is that treatment with light is good adjunctive and supportive treatment.

H. S. WILLIS

CANCER: A MANUAL FOR PHYSICIANS. Published Jointly by Michigan State Medical Society and Michigan Department of Health. Cloth. Pp. 225, 1944.

This manual of 225 pages was published jointly by the Michigan State Medical Society

and Michigan Department of Health for general practitioners to assist them in diagnosing early cancer and in determining the type of treatment that should be employed. It is well arranged. Chapters have been contributed by competent Michigan physicians, surgeons, radiologists, and pathologists. Clinical and laboratory diagnoses, pathology, and courses of cancers of most organs are described briefly but adequately without indulging in technical terminology. Surgical and radiological treatments are discussed but not in detail, because, as stated in the preface, "cancer therapy is a highly specialized matter requiring extensive experience—." In addition there are chapters dealing with subjects of general interest about cancer. One on "Care of the Advanced Cancer Patient" and another on "Neurosurgical Relief of Pain" are also appropriate. Similar manuals have been published in several states and undoubtedly have been useful, especially in making physicians "cancer conscious."

U. V. Portmann

Tuberculosis of the Ear Nose and Throat: Including the Larynx, the Trachea, and the Bronchi. By Mervin C. Myerson, M.D., New York City. Cloth. Price, $5.50. Pp. 291, with 88 illustrations. Springfield, Illinois: Charles C Thomas, 1944.

Myerson has presented impressions which he has gained from the study of one thousand cases of tuberculous laryngitis which, in his experience, occurs in 10 per cent of all cases of tuberculosis. He has described the pathology, symptomatology, diagnosis and treatment of this affection. At times rather didactic and lecture like, his story is concise. Differential diagnosis seems to present difficulties only seldom if one always keeps syphilis in mind. Treatment is unsatisfactory because the issue depends more upon the course of the almost always underlying pulmonary tuberculosis and the ability of the tissues to heal than upon the therapeutic maneuvers tried, chief of which are electric cautery and vocal rests.

The chapter on nontuberculous lesions of the larynx presents the chief elements of the differential diagnosis. Tuberculosis of the middle ear appears to exist more frequently than is commonly supposed, and is usually without symptoms until aural discharge or impairment of hearing develops.

One is greatly surprised to read that tuberculosis of the tonsils occurs in 25 per cent of cases of pulmonary tuberculosis in this author's series. This must mean, of course, that his were by the very nature of their referral, selective, for the physician treating the average case of tuberculosis is always surprised when he sees this, to him, very occasional complication. The author has wisely advised complete examination of the patient before tonsillectomy.

In his discussion of tuberculosis of the bronchi many a phthisiologist will take exception to the statement that recovery of tubercle bacilli from the orifice of a bronchus identifies the lobe containing the lesion, for many believe that any portion of the bronchial tree may contain tubercle bacilli at times, at least in the case with cavity. "Since atelectasis is the mechanism by which a local anoxemia is produced and the tubercle bacilli destroyed, the ulcero-granuloma which occludes a bronchus must be considered Nature's instrument for healing a cavity." Are tubercle bacilli so easily disposed of by nature? In several instances where the author has stepped out of his specialty to discuss the dynamics of tuberculosis and collapse therapy he has appeared to get into deep water. In general, however, his discussion of bronchial tuberculosis and especially of contraindications to bronchoscopic treatment are sound, and he makes an unusually interesting story of the reopening of a tuberculous bronchus as spontaneous retrogression occurs.

Altogether the physician not a specialist in conditions of the nose and throat may obtain helpful information by reference to this book.

H. S. Willis

Control of Pain in Childbirth: Anesthesia; Analgesia; Amnesia. By Clifford B. Lull, M.D., F.A.C.S., Clinical Professor of Obstetrics, Jefferson Medical College; Assistant Director, Philadelphia Lying-In Unit, Pennsylvania Hospital, and Robert A. Hingson, M.D., Surgeon, U. S. Public Health Service; Director, Post-graduate Medical Course, Philadelphia Lying-In Unit, Pennsylvania Hospital. With an Introduction by Norris W. Vaux, M.D., Obstetrician-in-Chief, Philadelphia Lying-In Unit, Pennsylvania Hospital. Cloth. Price, $7.50. Pp. 356, with 100 illustrations in black and white and 32 subjects in color, Philadelphia: J. B. Lippincott Company, 1944.

A comprehensive survey of obstetric anal-

gesia and anesthesia is presented in this volume. The value of the book is enhanced by the co-authorship involving thoroughly competent men in the two sciences concerned.

The book opens with a concise but adequate consideration of the anatomy and physiology of the pelvis pertinent to obstetric pain relief. This is followed by a classification and discussion of the various agents used to provide analgesia, anesthesia, and amnesia, describing their important characteristics. The mode of application of these agents is dealt with in some detail. Special attention is also given to the use and effects of the several agents in relation to the third stage of labor, cesarean section, and the puerperium. The final section of the book deals with the selection and use of the methods of pain relief in the presence of maternal complications, and also with their effects on resuscitation of the infant.

The book makes liberal use of illustrations and charts. Especially informative are the figures which show graphically the effects of the various agents for pain relief upon the vital organs of both mother and infant.

It is a compliment to the authors that although they have done more than anyone else to develop and refine caudal analgesia, they do not present it as a panacea. This procedure is given its rightful place among the others, each with its own attributes and disadvantages.

This work fills a long felt need and should find ready and widespread acceptance.

R. S. Haas

BOOKS RECEIVED

Radiologic Examination of the Small Intestine. By Ross Golden, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Director of the Radiological Service, Presbyterian Hospital, New York. Cloth. Price, $6.00. Pp. 239, with 75 illustrations. Philadelphia: J. B. Lippincott Company, 1945.

X-Ray Examination of the Stomach. A Description of the Roentgenologic Anatomy, Physiology, and Pathology of the Esophagus, Stomach, and Duodenum. By Frederic E. Templeton, M.D., Head of the Department of Roentgenology, Cleveland Clinic. Cloth. Price, $10.00. Pp. 516, with 297 illustrations. Chicago: University of Chicago Press, 1944.

The Gastro-intestinal Tract: A Handbook of Roentgen Diagnosis. By Fred Jenner Hodges, B.S., M.D., Professor of Roentgenology, University of Michigan Medical School, Ann Arbor, Michigan. Cloth. Price, $5.00. Pp. 320, with numerous illustrations. Chicago: Year Book Publishers, Inc., 1944.

Clinical Roentgenology of the Digestive Tract. By Maurice Feldman, M.D., Assistant Professor of Gastroenterology, University of Maryland; Assistant in Gastroenterology, Mercy Hospital; Consulting Roentgenologist, Sinai Hospital. Second edition. Cloth. Price, $7.00. Pp. 769, with 551 illustrations. Baltimore: Williams & Wilkins Company, 1945.

Mass Radiography of the Chest. By Herman E. Hilleboe, M.D., Medical Director, Chief, Tuberculosis Control Division. United States Public Health Service; Professorial Lecturer on Tuberculosis Control, George Washington University School of Medicine, Washington, D. C., and Russell H. Morgan, M.D., Surgeon (R), Medical Officer-in-Charge, Radiology Section, Tuberculosis Control Division, United States Public Health Service; Assistant Professor of Roentgenology, Absent on Leave, University of Chicago. Cloth. Price, $3.50. Pp. 288. with 93 illustrations. Chicago: Year Book Publishers, Inc., 1945.

The Urinary Tract: A Handbook of Roentgen Diagnosis. By H. Dabney Kerr, M.D., Professor of Radiology, State University of Iowa College of Medicine, and Carl L. Gillies, M.D., Associate Professor of Radiology, State University of Iowa College of Medicine. Cloth. Price, $5.50. Pp. 320, with numerous illustrations. Chicago: Year Book Publishers, Inc., 1944.

Escleróses Valvulares Calcificadas: Estudo Anátomo-Patológico, Radiológico et Clínico, Com Apresentaçao de Cem Casos. Pelo Dr. Roberto Menezes de Oliveria, Capitao Médico do Corpo de Saúde da Aernáutica, Diplomado em Medicina de Aviaçao pela Diretoria de Aeronáutica do Ministério da Marinha, etc. Paper. Pp. 155, with 67 illustrations. Rio de Janeiro, Brasil: Tipografia do Patromato, 1943.

Supervoltage X-Ray Therapy: A Report for the Years 1937–1942 on the Mozelle Sassoon Supervoltage X-Ray Therapy Department, St. Bartholomew's Hospital. By Ralph Phillips, M.S., M.B., F.R.C.S., D.M.R.E., Sir Halley Stewart Fel-

low, With the technical assistance of G. S. Innes, B.Sc., A.M.I.E.E., Physicist to the Mozelle Sassoon Department. With a Foreword by the Rt. Hon. The Lord Horder, G.C.V.O., M.D., F.R.C.P., Cloth. Price, 16s. Pp. 142, with 95 illustrations. London: H. K. Lewis & Co., Ltd., 1943.

X-Ray Isodose Curves. Compiled by the Staff of the Physics Department of the Royal Cancer Hospital (Free), London, S.W.3. 45 kv., 60 kv., 140 kv. (peak), 200 kv., 400 kv. (peak), isodose curves. Reprint of Percentage Depth Dose Tables supplied with each set of curves. Isodose curves contained in stout cardboard portfolios. Complete set at £10.10s od. Royal Cancer Hospital (Free), Fulham Road, London, S.W.3, England.

The Pathogenesis of Tuberculosis. By Arnold R. Rich, M.D., Associate Professor of Pathology, Johns Hopkins University School of Medicine, Baltimore. Cloth. Price, $10.50. Pp. 1008, with 89 illustrations. Springfield, Illinois: Charles C Thomas, 1944.

The Fundamentals of Electrocardiographic Interpretation. Second edition. By J. Bailey Carter, M.D., F.A.C.P., Assistant (Rush) Professor, Department of Medicine, University of Illinois College of Medicine; Attending Staff, Cook County Hospital, Augustana Hospital, Chicago. With a Foreword by Horatio Burt Williams, M.D., Dalton Professor of Physiology, College of Physicians and Surgeons, Columbia University, New York. Cloth. Price, $6.00. Pp. 406, with 309 illustrations. Springfield, Illinois: Charles C Thomas, 1945.

Shoulder Lesions. By H. F. Moseley, M.A., D.M., M.Ch.(Oxon.), F.R.C.S. (Engl and C.) F.A.C.S., Montreal, Canada, Lecturer in Surgery, McGill University; Assistant Surgeon, Royal Victoria Hospital. Cloth. Price, $4.50. Pp. 184, with 70 illustrations. Springfield, Illinois: Charles C Thomas, 1945.

Neuro-ophthalmology. By Donald J. Lyle, B.S., M.D., F.A.C.S., Lecturer on Neuro-ophthalmology, Department of Anatomy, Medical College of the University of Cincinnati; Attending Ophthalmologist to the Good Samaritan Hospital, Christ Hospital, Jewish Hospital, St. Mary's Hospital and Children's Hospital. Cloth. Price, $10.50. Pp. 398, with 529 illustrations. Springfield, Illinois: Charles C Thomas, 1945.

Control of Pain in Childbirth: Anesthesia; Analgesia; Amnesia. By Clifford B. Lull, M.D., F.A.C.S., Clinical Professor of Obstetrics, Jefferson Medical College; Assistant Director, Philadelphia Lying-In Unit, Pennsylvania Hospital, and Robert A. Hingson M.D., Surgeon, U. S. Public Health Service; Director, Post-graduate Medical Course, Philadelphia Lying-In Unit, Pennsylvania. With an Introduction by Norris W. Vaux, M.D., Obstetrician-in-Chief, Philadelphia Lying-In Unit, Pennsylvania Hospital. Cloth. Price, $7.50. Pp. 356, with 100 illustrations in black and white and 32 subjects in color. Philadelphia: J. B. Lippincott Company, 1944.

Plaster of Paris Technic. By Edwin O. Geckeler, M.D., Associate Professor of Orthopaedic Surgery, and Chief of the Fracture Service, Hahnemann Medical College and Hospital, Philadelphia. Fellow of the American College of Surgeons, Fellow of the American Academy of Orthopaedic Surgeons, etc. Cloth. Price, $3.00. Pp. 220, with 208 illustrations. Baltimore: Williams Wilkins Company, 1944.

A Bibliography of Aviation Medicine: Supplement. By Phebe Margaret Hoff, Ebbe Curtis Hoff and John Farquhar Fulton. Cloth. Price, $2.50. Pp. 109. Published by the Committee on Aviation Medicine, Division of Medical Sciences, National Research Council, Acting for the Committee on Medical Research. Office of Scientific Research and Development, Washington, D. C. Distributed by Charles C Thomas, Springfield, Illinois.

Anatomy: As a Basis for Medical and Dental Practice. By Donald Mainland, M.B., Ch.B., D.Sc. F.R.S.E., F.R.S.C., Professor of Anatomy, Dalhousie University, Halifax, N.S., Canada. Cloth. Price, $7.50. Pp. 863, with 61 illustrations. New York: Paul B. Hoeber, Inc., 1945.

Poet Physicians: An Anthology of Medical Poetry Written by Physicians. Compiled by Mary Lou McDonough. Cloth. Price, $5.00. Pp. 212. Springfield, Illinois: Charles C Thomas, 1945.

Abridged Scientific Publications. From the Kodak Research Laboratories. Volume xxv, 1943. Paper. Pp. 443, with numerous illustrations. Rochester, New York: Eastman Kodak Company, 1944.

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 103 Rutledge Ave. Charleston, S. C.

A METHOD FOR IMPROVING ROENTGENOGRAMS OF THE CHEST

By CLARENCE J. ZINTHEO, JR., B.Sc.
Firland Sanatorium
RICHMOND HIGHLANDS, WASHINGTON

THE appearance within recent years of the so-called "automatic control panel" for high-powered roentgen-ray generators makes practical a change for the better in the usual method of adjusting roentgen-ray exposure of the chest to size of the patient. Heretofore it has been the custom to change the voltage according to the thickness and type of chest but technically this is not the best approach because the contrast of the resultant roentgenograms varies even if the maximum blackening in the lung fields is held constant. There are three principal factors responsible for this change in contrast: (1) at the higher voltage used on a larger patient, the rays generated are of shorter wavelength; (2) there is increased scattering because of the shorter wavelength radiation used; and (3) there is increased scattering from the greater mass of tissue penetrated. Shorter wavelength radiation and increased scattering both produce a roentgenogram of lessened contrast. Conversely, with a patient thinner than the standard, an exposure with lowered kilovoltage produces a roentgenogram of increased contrast. Differences in contrast are only too apparent in any group of routine roentgenograms of the chest.

It would be an advantage if all roentgenograms of the chest, regardless of the patient's size and build, could be of the same technical quality: the same contrast and the same maximum blackening within the lung fields. To realize this the voltage used for a heavier patient should not be increased but rather should be decreased in order that the longer wavelength radiation so produced might balance the flattening of the roentgenogram caused by greater scattering mass. The increased exposure required to compensate for the greater absorption plus the loss from lowered voltage must be made up in some way which will not change the quality of the finished roentgencgram. Assuming that the basic voltage is, as it should be, high enough to adequately penetrate the heaviest subjects, variable patient absorption may best be compensated for by changing the milliampere-seconds used. Change of distance is unacceptable for the resultant change in geometric unsharpness is undesirable. Change in time of exposure can be considered where an impulse timer is available permitting changes by steps of 2 impulses (an exposure with an odd number of impulses should be avoided) although the variation in movement unsharpness is not to be desired. In fact, where an automatic control is not installed, a standard technique based upon 6 impulses may be adopted and changed to 4, 8, 10 or 12 impulses as the case at hand may require with results from the standpoint of the quality of the roenrgenogram that justify the method. For it may be better to have good contrast on all types of cases at the expense

of possible movement unsharpness on a few of the heavier ones (at 1/10 second not more than one in five roentgenograms is apt to be taken during an instant when lung movement at any place is enough to cause noticeable unsharpness) than to accept poorer contrast quality in a considerable number of cases. The best way is by a change in milliamperage but heretofore it has not been possible to do this conveniently and rapidly and still keep control of the voltage calibration; this has been especially true with the rotating anode tubes used with high-powered generators for they do not operate above saturation potential. The automatic controls now make it possible to vary milliamperage freely.

Automatic control refers to the modern control board for use with a 500 ma. transformer and rotating anode tube, which includes these three features: (1) a "technique selector" by means of which one can set a single control to a given "station" and secure a stated milliamperage; (2) an arrangement whereby roentgen tube space-charge is compensated so that milliamperage is held constant as kilovoltage is changed, and (3) an arrangement whereby the kilovoltage indicator reads the true calibration at whatever milliampere station may be selected. The technique selector on such units makes possible rapid and accurate setting of milliamperage to, usually, any multiple of 100 ma. up to and including 500 ma.; it is this ease, coupled with the accurate knowledge of kilovoltage calibration at each station, that permits the use of milliamperage as well as kilovoltage as a variable for routine roentgenography of the chest. Steps of 100 ma. are too coarse to allow use of milliamperage as the only variable so with present machines the finer control of 1 kv. autotransformer steps must still be used, but with the combination a positive move in the direction of holding contrast uniform on the roentgenograms of all patients can be made.

In practice, a technique standard for the average range of cases can be worked out on the basis of 300 ma. over a scope of about 6 kv. For example, an 18 cm. chest might call for an exposure of 63 kv. and the voltage would be increased to 69 kv. for 21 cm. chests. But in the next bracket where voltages up to 74 kv. would usually be called for, the selector is set at 400 ma. and 5 kv. less voltage is given, while in the higher range which might ordinarily require 75 kv. or more the selector is set at 500 ma. and 9 kv. subtracted from the scale. Conversely, for thin patients, instead of going below 63 kv. the selector is set to 200 ma. and 6 kv. added to what would have been given. Thus, except for unusual conditions, the films are all exposed within the range of 63 to 69 kv.; not much change in contrast could be expected from the change in radiation over that small a range, so such differences in roentgenograms as do occur are probably caused by the scattering factors of the flesh. This method has proved both practical and beneficial in routine use; both milliamperes and kilovolts can be rapidly set at the desired combination, and the resultant roentgenograms, especially of the heavier cases, are decidedly improved. Identical contrast on roentgenograms of every type of case cannot be expected, for only a partial step in the necessary direction can be taken and it is to be anticipated that after major differences in contrast are compensated for the control of smaller changes will be more difficult as the influence of obscure factors becomes effective, but because of the ease with which a considerable improvement can be made the method is worth trying.

A 300 ma. basic technique is adequate. In addition to the kv-ma. combination outlined above, other factors as used at Firland Sanatorium include: 1/20 second, 6 foot distance, detail type screens in bakelite cassettes, and development for 2½ minutes at 70° in speed developer.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

NECK AND CHEST

Edwards, H. R. Tuberculosis in industry. *Am. J. M. Sc.*, April, 1943, *205*, 571–581.

The author of this study is Director of the Bureau of Tuberculosis, Department of Health, New York City. This paper is a statistical evaluation of the findings in the roentgenographic examination of 15,644 union workers in various industries in New York City. The findings in these studies confirmed previous observations that as a group the employed population invariably reveals less significant pulmonary tuberculosis than those employed on relief. It is also obvious that the prevalence of tuberculosis varies considerably on the basis of occupation but that so far as evidence is available here there is no reason to believe that the occupation studied can be considered as direct causative agent in tuberculosis.

There was found to be a prevalence rate of 0.61 per cent with evidence of clinically significant pulmonary tuberculosis. The prevalence of chronic pulmonary tuberculosis of apparent arrest was 2.9 per cent. The prevalence of healed primary lesions for the entire group was 12.43 per cent.

Surveys of this type have been shown to be valuable in revealing the prevalence of chronic pulmonary tuberculosis and should be the basis for a definite program in medical care of the industrial employee. Such a service should provide pre-employment as well as periodic re-examination.

The handling of the pulmonary phase of such services requires competent clinicians trained in chest pathology; otherwise overemphasis may be placed on lesions of no importance as well as the reverse. If such work is properly carried out, there is no reason to believe that the worker will be unjustly discriminated against because he presents a pulmonary lesion.

It is felt that the establishment of a Tuberculosis Control Program in all industries is amply justified. Such a program is greater than can be handled by the local department of health and is a responsibility that should be shared jointly by management and organized labor.—*J. J. McCort.*

Ehrlich, David E., Schiller, Israel A., and Edwards, Herbert R. Army x-ray examination for tuberculosis. *Am. Rev. Tuberc.*, Feb., 1943, *47*, 113–120.

This study is based upon 114,130 roentgenographic examinations of selective service registrants and National Guardsmen such as examined at the Army physical examination centers of the Southern New York District. In particular, the authors are interested in the comparative use of 14×17 inch paper films versus the 4×5 inch photoroentgenograms.

They found that reclassifications occurred about half as frequently when restudying cases which had first been studied by the 14×17 inch paper films, versus the 4×5 inch films. No mention is made of stereoscopic studies with either of these methods. The authors are very fair in their explanation of the difference in their trust of these two methods—stating that they were less familiar with the miniatures.

Taking into consideration the various bases for rejection because of findings in the chest, as stipulated in MR 1–9, the following conditions were identified: tuberculosis, primary and reinfection types, 352 cases; bronchiectasis, 57; pleural lesions, 21; spontaneous pneumothorax, 13; mediastinal lymphadenopathy, 12; cysts and tumors, 12; pneumonias, 11; fibrosis, 8; pneumonoconiosis, 4; undetermined lesions, 4; bronchial stenosis, 2; diaphragmatic hernia, 2 and congenital heart abnormalities, 2. Considering all of these 1.14 per cent were rejected; 1.01 per cent being identified as chronic pulmonary tuberculosis (0.38 per cent considered to be clinically significant).

It is estimated by the authors that the savings to the Federal Government, by these rejections, amounted to approximately thirteen million dollars.—*A. A. de Lorimier.*

Thomas, Morris C. Types of lung diseases encountered in an Army camp. *Am. Rev. Tuberc.*, July, 1943, *48*, 1–7.

The author has studied chest conditions such as those found at the Station Hospital, Fort Knox. Three groups of personnel were concerned: those of the Regular Army (physically capable of the rigors of field duty), the first selectees of 1941 (carefully selected as of physical and mental perfection), and the inductees (selected after the break of war, and brought in on such a large scale that inconspicuous defects could be passed—requiring the stress of training to uncover).

All of these groups were treated alike and the author has been interested in noting differences in their disease findings.

Spontaneous pneumothorax was encountered occasionally; traumatic pneumothorax, rarely. Bronchiectasis appeared to be more common than tuberculosis (possibly because it was more difficult to identify the former at the induction centers). There were many asthmatics (probably because history of asthma did not suffice for exemption; witness of definite attacks being necessary). Hemoptysis was not taken at face value; it occurred too frequently among malingerers and bronchoscopies were frequently performed—for it was "learned that a malingerer doesn't relish a second bronchoscopy." Three pulmonary malignancies were identified, even in this younger group (2 carcinomas and 1 sarcoma). Lung cysts and pneumoconiosis were oddities (apparently eliminated at induction centers). Three cases of rheumatic involvement of the lungs (accompanied by pericarditis and endocarditis) occurred. There was one epidemic of influenza, occurring in December, 1940 (with no pulmonary complications).

The pneumonias accounted for the largest group of major pulmonary infections, with 2 deaths in two years. The peak of such disturbance occurred in March and April. There appeared to be several distinct types.

Only a small group were pneumococcic. These followed the customary course, except that they were admitted for hospital care earlier than in the usual civilian practice; after sulfonamide therapy there appeared to be very little progress of the pathological process in the lungs.

In February, 1941, there seemed to be a second form of pneumonia—having prodromal symptoms for one to five days and the pneumonia itself developing as a complication of pharyngitis, or other disease. The symptoms of non-productive cough, substernal pain, pleural pain, fever of 100–103 F., and white blood counts averaging around 15,000 were all out of proportion to physical and roentgen findings (a patchy, lobular type of consolidation frequently confined to the right middle lobe; occasionally, the appearance of cavitation; clearing of one area and subsequent consolidation elsewhere). Pneumococci could not be found in these cases.

Later in the spring of 1941, a third form of pneumonia developed—the patients were quite ill; white blood counts averaged over 25,000; non-typable pneumococci were demonstrated in the sputum of about half the group, and there was expectoration of frank blood in many cases. Roentgenography revealed fairly extensive involvement—the appearance of incomplete lobar consolidation.

In the fall of 1941, a fourth type of pneumonia appeared—symptoms varied from none to severe; roentgenography revealed extensive involvement in some cases where there were few or no symptoms; sputum was frequently mucoid and blood tinged; sore throats, headaches, anorexia were frequent; cyanosis was absent or faintly perceptible; some had no fever though the majority showed a fever of 102–104° F.; respirations were normal while the pulse coincided with the fever curve; white blood counts were normal or there was a mild leukocytosis, not exceeding 15,000. Serial roentgenography revealed a tendency toward fleeting involvements with hilar shadows enlarged and otherwise slight mottling to extensive consolidations.

A fifth form of pneumonia was noted during 1942—sudden onset with extreme prostration; harassing cough uncontrolled by large doses of codeine; sputum blood-tinged to frank blood; severe retrosternal pain; cyanosis which was persistent and only partially relieved by oxygen; physical finding of râles through most of the lung fields, and a constant finding of white blood count below 8,000. The severity of this infection appeared to be proportionate to the degree of leukopenia. Convalescence was slow. There was no response to chemotherapy.—*A. A. de Lorimier.*

Rilance, Arnold B., and Gerstl, Bruno. Bronchiectasis secondary to pulmonary tuberculosis. *Am. Rev. Tuberc.*, July, 1943, *48*, 8–24.

This report is concerned with 47 tuberculous patients in whom bronchiectasis was identified by way of bronchography or found at autopsy. In 35 of these, the diagnosis was based upon

lipiodol studies alone; in 12, the bronchial dilatations were demonstrated at autopsy. In 3 of the 35 patients, the bronchiectasis was considered to be independent of the tuberculous process; in the other 32 it was thought to be the direct result of the tuberculosis. In the former group, there was the typical foul sputum with clubbing of the fingers, long before any evidence of tuberculosis. Among the latter group, the sputum was not foul and clubbing of the fingers was not noted.

The incidence of bronchiectasis in tuberculosis has been variously reported; cited to be as often as 61 per cent of active cases. It may be due to bronchial stenosis, pulmonary fibrosis or to dilatation directly resulting from impairment and infection.

The findings of 7 cases are described in detail. The authors are of the opinion that the bronchiectasis is usually not directly due to the abnormality of bronchial functioning; that the few which are so related are featured by greater severity of symptoms of a bronchiectatic character. Suspicion of the presence of tuberculous bronchiectasis should be aroused when patients present the clinical symptoms of tuberculosis, in association with either persistently negative sputum or a roentgen picture which by itself would be interpreted as a healed tuberculous lesion.

In 1 of the cases, the pathological studies indicated development of saccular bronchiectasis by way of re-epithelialization of a tuberculous cavity.—*A. A. de Lorimier.*

Ellison, Richard T., and Gershon-Cohen, J. "Physiological" changes in breath sounds and tuberculosis. *Am. Rev. Tuberc.*, May, 1943, *47*, 449–459.

An effort has been made to correlate alterations in physical signs in the right apex with changes as shown roentgenographically and with tuberculin reactions. This study involved examination of 450 cases which were unselected but outpatients in a clinic (Philadelphia) for tuberculosis.

Tuberculous involvement in the hilar and tracheobronchial lymph nodes appeared to produce retraction of the apex, asymmetry of the musculature and subcutaneous tissues and alterations in breath sounds. The primary phase of tuberculosis appeared to be most frequently responsible for these lymphatic and secondary changes. The atrophy of musculature and subcutaneous tissues may be explainable on the basis of hypofunction, but the authors emphasize that hypoventilation may be the essential factor.—*A. A. de Lorimier.*

Leonidoff, Aleksei A. Tuberculosis in mentally ill patients. *Am. Rev. Tuberc.*, May, 1943, *47*, 460–468.

There is growing concern because of the prevalence of tuberculosis in hospitals for the mentally ill. At the Hudson River State Hospital at Poughkeepsie, New York, a careful search has been made of patients, in this regard, especially since 1936. Mantoux tests with PPD and also the Vollmer patch test were compared. The Mantoux showed the greater incidence of positive reaction, though the difference was not very great. There were shortcomings to either method, as far as cooperation of the patients was concerned. Roentgenoscopy was found to be unsatisfactory for several reasons: lack of familiarity with the procedure by many psychiatrists; the time required; the lack of cooperation of the patient, and the fact that this method fails to detect "a little over 5 per cent of pulmonary tuberculosis." Ordinary physical examinations were likewise unreliable —as were also details of history and present illness. Even the matter of weight loss could not be considered suggestive of tuberculosis, since so often this was due to psychic disturbance. Sedimentation rates were studied but they were considered to be relatively tardy in their indications. Pulse rate and temperature studies presented confusing data.

Finally, mass roentgenography was instituted and 752 of the 7,466 patients were isolated on the basis of suspicious evidence. Corroborative studies revealed an incidence of 8.8 per cent of significant tuberculosis. Similar studies were thereafter accomplished on employees—resulting in the identification of tuberculosis in 2.8 per cent.

As a result of these revelations, certain policies were established: to re-examine all employees every four months, or more frequently; to dissuade younger persons against work in a tuberculosis service; to enforce prophylactic measures—the wearing of gowns and masks and observing personal hygiene; the giving of talks, stressing the dangers of tuberculosis, and urging attendants to take rest when ill.

The value of roentgenography is especially

emphasized. It is appreciated especially for patients who have been subjected to shock therapy.

Of the tuberculous patients 66.4 per cent were dementia praecox cases; 10.2 per cent, manic depressives; 3.8 per cent, arteriosclerotics; 2.4 per cent, mental deficiency cases. Most of these were diagnosed as having tuberculosis after being in the institution from five to fifteen years. The group between the ages of thirty and sixty were the most frequently afflicted. There were only 2 cases of tuberculous meningitis. Tuberculous enterocolitis, epididymitis, and laryngitis occurred at about the same frequency and with about the same course as among mentally normal patients. Those patients which were the most cooperative seemed to get along the best.

The results with pneumothorax were unfavorable, apparently because of non-cooperation of the patient. Likewise, thoracoplasty was found not to be especially practical—though preferable to pneumothorax.

The author recommends special study of tuberculosis by psychiatrists.—*A. A. de Lorimier.*

Herrick, W. W., Tyson, T. Lloyd, and Watson, B. P. Association of hydrothorax with ovarian fibroma (Meigs's syndrome). *Arch. Int. Med.*, March, 1943, 71, 370–376.

The authors present this case in order to call attention to the significance of the combined thoracic, abdominal and pelvic features. The literature on this subject has been summarized by Meigs* under whose name the syndrome is now classified.

The case presented here is that of a woman, aged seventy-five, with a history of five normal pregnancies. Three months after the patient came under observation there was found to be edema of both feet, clubbing of the fingers was noted, there was persistent anemia of the secondary type, and unequivocal signs of fluid were found at the right base. The first thoracentesis produced 1,000 cc. of clear, straw-colored fluid. The specific gravity was 1.021. A stained smear of the centrifugate showed a moderate number of red blood cells, 10 to 15 small mononuclears per high power field and a few large mononuclears. No polymorphonuclear leukocytes were seen nor cells containing mitoses. Cultures showed no growth. Guinea pig inoculations gave negative results. During the following fourteen months nine aspirations, each of 1,000 cc., were performed. Aspiration was done whenever dyspnea, marked thoracic discomfort and the physical signs of an appreciable amount of exudate demanded the procedure. Careful observation of the temperature during this time revealed no fever.

A pelvic examination revealed a tumor in the right side of the pelvis, freely movable between the hands and somewhat suggestive of an ovarian enlargement. At no time were there convincing signs of ascites. At operation, the large tumor was found to involve the right ovary, which had a narrow pedicle. The left ovary was the seat of the smaller tumor and also had a narrow pedicle. Both pedicles were clamped and the ovaries removed.

Convalescence was uninterrupted. The last aspiration of the chest was done two days before the laparotomy, 1,100 cc. of fluid being removed with a small residue remaining. Postoperatively the signs of the remaining fluid appeared within a week. There has been no recurrence of the pleural fluid.

Thus far there has been no satisfactory explanation of the association of ovarian fibroma with hydrothorax and ascites. The possibility of an abnormal communication between the two serous cavities may be dismissed since the amount of fluid in one cavity is not influenced by removal of fluid from the other. That a low level of serum protein is concerned seems unlikely. If accumulation of fluid in the serous cavities was a result of diminution in serum protein, edema of the subcutaneous tissues should be present. Although noted in this case it was slight and transitory, while in most reported cases it was not observed.—*J. J. McCort.*

Gordon, Burgess, Charr, Robert, and Savacool, J. Woodrow. Pleural effusions in pulmonary tuberculosis. *Am. Rev. Tuberc.*, Jan., 1943, *47*, 35–40.

Eighty selected cases of pleural effusion were studied at the Chest Department of the Jefferson Hospital (Philadelphia) and the Whitehaven Sanatorium; autopsies were performed in 35 of these. The postmortem studies included injection with radiopaque substance and roentgenography to determine the location and characteristics of the blood vessels.

In 20 of the necropsied cases, the fluid was

* Meigs, J. V. Fibroma of the ovary. *Ann. Surg.*, 1939, *110*, 731–754.

non-purulent—serous, serofibrinous or hemorrhagic. Tubercle bacilli were found, by direct culture or by sedimentation, in all of these. The pleural surfaces showed a fibrinous exudate and loss of the normal lustre. Superficial tubercles were common, especially along the anterior surface of the lung. The posterior surfaces of the lung showed congestion and definitely fewer caseous nodules. Histological studies revealed tubercles in the pleura as well as in the subpleural zones—indicating that the tubercle bacilli likely gained access to the fluid directly.

Clinical studies indicated that, in most instances, the fluid was clear in the beginning and that then it was very difficult to isolate the organisms. As the fluid became more turbid, positive cultures were obtained and bacilli were found in the sediment. Acute congestion of the pleura and subpleural zones was found in cases of hemorrhagic effusions. These vascular changes apparently occurred prior to caseation—leading the authors to believe that hemorrhagic effusion is probably a precursor to caseation. They believe that hemorrhagic effusion leads to pleural thickening and, thereafter, subsidence of the congestion, and to a non-hemorrhagic effusion.

In areas of caseation, the blood vessels were narrow (arterioles showing definite thrombi and some of the branches being obliterated). With caseation, the vessels were squeezed flat and held empty; ischemia existed in the nodules—resulting in liquefaction and cavity formation.

Long continued effusion seemed to produce a diffuse fibrosis, with sclerosis of the vessels and a generalized ischemia of the lung. The fibrosis was especially marked in the peripheral regions. Regardless, caseation continued—contradicting therapeutic value of splinting the lung by the fluid. It is suggested that, instead, the fluid might produce permanent atelectasis, with bronchiectasis, abscess and other complications.

It is emphasized that tubercles located in the anterior part of the lung show a definite tendency to rupture, probably due to the greater thoracic movements in the anterior chest. Though thoracocenteses may result in decreased lubrication between the moving surfaces of the parietal and visceral pleurae, and though such measures may lead to sinus formations and secondary infection, the authors recommend repeated aspirations of the fluid. They use an 18 gauge curved needle and they suggest that secondary infection be counteracted by the use of sulfadiazine. The aspiration should be accomplished in the posterior axillary line (to minimize the pain and to counteract the possibilities of perforating tubercles which are more numerous in the anterior chest). Following each aspiration, the patient should lie on the opposite size for one or two hours, thereby permitting the needle tract to close.—*A. A. de Lorimier.*

Sweany, Henry C., Levinson, Samuel A., and Stadnichenko, A. M. S. Tuberculous infection in people dying of causes other than tuberculosis. *Am. Rev. Tuberc.*, Sept., 1943, *48*, 131–173.

The authors speak of the enigmatic status of knowledge relative to the source and early course of tuberculous infections. The object of their study was to reconsider the incidence of active tuberculous lesions in people who are apparently well; likewise, among ill people who had no recognized symptoms or the diagnosis of tuberculosis; to consider the mode of development—as correlated with age, race, sex, occupation or intercurrent diseases; to study means of identifying dangerous lesions; to consider the condition of the tubercle bacillus in one and another type of lesion and in one and another location of a lesion, and, finally, to consider the most appropriate methods of clinical investigation.

The study included bacteriological, pathological, and roentgenological aspects pertaining to 300 patients who had died of conditions other than tuberculosis but who were found to have lesions in the lungs or related lymph nodes.

Of these, 84.7 per cent were found to have calcifications believed to be associated with tubercles; of this group many had lesions which were too small for satisfactory study but dissection was accomplished of dense lesions removed from 70.7 per cent of the 300 patients. Of these 2.4 per cent had a history or clinical findings of tuberculosis, but no tubercle bacilli were ever demonstrated during life (gross and microscopical evidence was found in 1.9 per cent).

Seventy-five per cent of the lesions which were dissected appeared to be of the primary phase; 23.6 per cent, the reinfection phase;

the rest unclassifiable. Seven per cent of the cases of the first decade showed calcification; 55 per cent of those of the second decade; 80.4 per cent of those of the third, and approximately 100 per cent of those of later decades. Seventeen per cent showed positive cultures, while only 7.6 per cent showed acid-fast bacilli on smears and 2 per cent showed positive smears but negative cultures. In 3 of the cases, tuberculous activity was identified on the basis of pathological evidence of inflammation around the tubercle. In all, 20.8 per cent of the group revealed activity in one way or another.

It appeared that tubercle bacilli are prone to live in or near the outer capsules of tubercles —in microscopical tubercles, in monocytes and giant cells located in close proximity to the main lesions. However, cultures of these regions were usually negative. Positive cultures were obtained in 80 per cent of the tubercles of less than one year of age—with a gradual decrease to an entire negative series of cultures by the end of fifteen years. Fibrosis appeared to be a favorable type of reaction. It seems that widespread lesions develop a higher degree of immunity against the bacilli.

Of the cases which showed "densely calcified" or partially calcified lesions, roentgenographically, 4.3 per cent were identified as chondroma, osteoma, lipoma, fibroma, or phlebolith.

The authors conclude that "clinicians must continue to investigate every clue, roentgenologists must still look for the small, soft flecks and infiltrates or varying types of calcified lesions, and bacteriologists must search for bacilli as they have heretofore."

Softness of a lesion, size, the fuzziness of the borders, and cloudy appearance speak for relatively recent development. Fuzzy, round infiltrates in the apical regions are more prone to harbor living bacilli than are calcified lesions in the bases.

In general, the rather arbitrary criteria utilized by the Army and Navy are considered practical.

Many of the lymph node lesions are not ordinarily discernible. Multi-angular views and planigraphic studies may be indicated in some of these cases. Stringy fibrosis should be regarded with suspicion for a completely healed fibrous lesion is prone to be so thin and so surrounded by emphysema as to arouse little or no suspicion. Apical caps are usually benign or non-tuberculous, though the subpleural regions should be carefully studied and any evidence of pleural fluid should be viewed with alarm.

Approximately 1 in 4 or 5 cases which showed a positive tuberculin reaction were found to have positive cultures (cases showing the strongest reaction most frequently showed living bacilli).

Many of the older individuals without demonstrable tuberculosis had lived in heavily infected districts. Rather than considering that they had never been infected, the authors speculate that many of them had very small lesions, probably progressively involuted lesions or that they had extrapulmonary lesions. They remark that regressive lesions begin to extinguish tubercle bacilli very soon after encapsulation (within three to six months) and that by the time they show calcification (in one to two years) the majority of the bacilli are dead (though some may live under such conditions for more than ten years).

In none of the cases which resembled silicosis could there be found any sign of recent tuberculous activity—though it appeared that the defense mechanism may become exhausted within old nodules.

The various phases of tuberculous infection are reviewed: invasion usually occurring by way of the lungs (only about 10 per cent, by way of the intestines or the upper respiratory tract); sensitization developing in three weeks to three months (with progressive healing, this sensitization may persist for five years to life; it diminishes as healing occurs though it may persist for three or more years after the bacilli are dead). Overwhelming disease may result in complete anergy. Reinfections may cause resensitization.—*A. A. de Lorimier.*

Tepper, Leo, and Jacobson, George. Pulmonary manifestations in extrapulmonary tuberculosis. *Am. Rev. Tuberc.*, Feb., 1943, *47*, 156–167.

Roentgenography of the chest was accomplished in 100 patients having extrapulmonary tuberculosis and also in another group of 100 patients having pulmonary tuberculosis, but no evidence of extrapulmonary tuberculosis. Of the former group, 79 showed evidence of post primary pulmonary involvement—most of the lesions being fibrotic and calcific, apparently inactive, with proliferative, nodular, and exudative manifestations. Forty-four of these 79 cases showed subapical distribution of lesions, bilaterally—which feature led the authors to believe in their hematogenous

origin. Fifteen of these cases showed cavitation and, of these, 12 had positive sputa—though only 1 showed evidence of bronchogenic spread. Otherwise, serial studies indicated a general tendency for hematogenous progression rather than bronchogenic spread among the group having extrapulmonary lesions. This was quite in contrast to the findings among the 100 cases of strictly pulmonary lesions—where progression appeared to be by bronchogenic spread.—*A. A. de Lorimier.*

Lintz, Robert M. Spontaneous mediastinal emphysema. *Arch. Int. Med.*, Feb., 1943, *71*, 256–261.

At the time this paper was written the author had found in the literature only 13 instances of this syndrome occurring spontaneously. Because of the ease with which the diagnosis is made and because of the importance of differentiating spontaneous mediastinal emphysema from various vascular accidents, it was deemed advisable to report this case.

The patient was a twenty-two year old autumobile mechanic. He was admitted to the hospital complaining of severe pain of one hour duration in the chest on the left side. At the time the pain appeared he was sitting quietly in a chair reading a newspaper and stated that he had not done any strenuous work that day. On physical examination there was a definite area of subcutaneous emphysema over the lower portion of the anterior wall of the chest on the left side. Anteriorly from the left costal margin to the third rib 'boiler-like' sounds of loud intensity were heard; extending into the axilla finer crackling sounds were audible. These 'boiler-like' sounds might be compared to the noise that one hears when crumpling a hand full of cellophane close to the ear, and could be heard distinctly several feet from the patient's chest. By the following morning, eighteen hours after admission, all that could be heard were a few crackling sounds over the precordium, appearing only during diastole and heard best with the patient lying on his left side.

The patient felt fine and because he had not had any pain or discomfort since the previous evening insisted on going home.

A roentgenogram of the chest taken at the time of admission showed a small pneumothorax at the apex of the left lung. Other roentgenograms were taken in an effort to discover air in the mediastinum but none could be made out.—*J. J. McCort.*

Adcock, John D. Spontaneous interstitial emphysema of the lung: with mediastinal, retroperitoneal and subcutaneous emphysema. *Arch. Int. Med.*, May, 1943, *71*, 650–657.

A case of spontaneous interstitial emphysema of the lung with extension of air into the retroperitoneal and subcutaneous tissues is reported. This occurred in a sixty-two year old white man who was undergoing fever therapy for central nervous system syphilis. The first change to be noted was a widespread subcutaneous emphysema. At no time did the patient complain of pain and this is thought to have been due to the ease of escape of the air from the mediastinum, which prevented the development of high mediastinal pressure.

A roentgenogram showed evidence of mediastinal air. There was a small density at the base of the left lung which was interpreted as an area of atelectasis. Just above this there was an area of greater penetration which suggested a small area of lung containing a larger than normal amount of air. A small amount of subcutaneous emphysema could be seen in the neck. A roentgenogram was obtained during expiration to make certain that a small pneumothorax was not overlooked and none could be demonstrated. A roentgenogram of the abdomen showed a striking amount of free subperitoneal emphysema. The small area of transient atelectasis was apparently responsible for the development of the interstitial emphysema of the lung in this instance. It was possible to locate clinically the site of escape of air from the alveoli into the perivascular and interstitial tissues of the lung.

The signs rapidly disappeared and eight days later nothing abnormal could be detected on examination of the patient. Another roentgenogram of the chest at this time showed a return to normal with complete disappearance of the small area of density at the base of the left lung and the area of emphysema above it.—*J. J. McCort.*

Huang, Chia-Ssu. Tuberculous tracheobronchitis. *Am. Rev. Tuberc.*, May, 1943, *47*, 500–508.

One hundred and fifteen cases of active pulmonary tuberculosis which were autopsied at the University of Michigan Hospital from July, 1936 to December, 1941, were analyzed with respect to lesions in the larynx, trachea and bronchi. Lesions were found in one or

another of these passages in 50.4 per cent of the group; 42.7 per cent showed tracheobronchial tuberculosis.

The incidence of tuberculosis of the larynx, trachea, and bronchi, with open cavities, was three times as high as that without them. Less than half of the group which showed no extrapulmonary tuberculosis showed these lesions while practically half of those with extrapulmonary lesions showed them. Of the latter, intestinal tuberculosis was the most common type. Only 1 case out of 7 having negative sputa showed these lesions.

Histopathologically, the lesions were differentiated as ulcerated or as non-ulcerated (discrete submucosal tubercles or diffuse tuberculous granulation). About two-thirds of the lesions were ulcerated.

The author believes that tuberculous tracheobronchitis is, in most cases, brought about by the direct invasion of the mucous membrane or mucous glands by tubercle bacilli directly from the cavernous lesions in the lungs.—*A. A. de Lorimier.*

Bobrowitz, I. D. The round pulmonary tuberculous focus. *Am. Rev. Tuberc.*, May, 1943, *47*, 472–483.

The author has been interested in "round foci," "solitary foci" or "circular lesions" as found in a series of 55 tuberculous patients. These lesions were reviewed roentgenographically and by clinical records.

Usually these foci were found in the infraclavicular region and within the area of the first anterior intercostal space; in only 4 instances, in the apex; occasionally, in the third interspace. No basal lesions were observed. The foci were sharply marginated in 70 per cent of the cases; surrounded by fine nodules or infiltration, in the others. Likewise, 70 per cent had a negative sputum (though 15 per cent of these had a history of positive findings). In 1 case, the history described a cavity at a site where the round focus was identified and in 3 patients, the round lesions were present in re-expanded pneumothorax lungs (where the pneumothorax had been instituted because of cavitation). In 3 of the patients, the round foci developed in regions where previously there had been no evidence of parenchymal changes. All of these lesions gradually contracted, though one of them showed an intermediary stage of enlargement and a suspicious area of clearing.

In 7 of the patients, the round foci developed with spontaneous closure of cavities (which had persisted for seven months as an average). All but 1 of these patients had positive sputum.

The author attributes the development of most round foci to obliterative phenomena concerned with cavitations. Though he considers these lesions to be relatively benign, he cites the warning that they may produce cavitation and that they must be carefully watched.—*A. A. de Lorimier.*

Bogen, Emil, and Rogers, Arthur. The scaphoid scapula in tuberculosis. *Am. Rev. Tuberc.*, March, 1943, *47*, 303–307.

The configuration of the vertebral border of the scapula has been evaluated with respect to 100 patients at the Olive View Sanatorium (California), by physical examination and by routine roentgen studies. The authors found definite predominance of a straight or a concave border among these patients. Only 23 per cent showed a convex border.

They call attention to the conclusions described by Graves—that the straight or the concave configuration of the vertebral border of the scapula is found mainly among individuals who are poorly adaptable, peculiarly vulnerable, and unduly susceptible to disease; they being the constitutionally inferior and the short-lived individuals of the race.

Graves had described a progressive increase in the incidence of the convex configuration, in accordance with age—65 per cent of all scapulae at ten years being scaphoid whereas by the eight decade, only 20 per cent were of this type. He accounted for this difference on the basis of early death of the individuals with this type. However, the authors lean to Wolff's law and Steindler's dicta—that "the form and architecture of bone corresponds mathematically to the physical demands of external stresses." They suggest that the activity of the levator scapulae may be especially concerned in changing the configuration of the vertebral borders from concave to convex.—*A. A. de Lorimier.*

Sims, J. L. Multiple bilateral pulmonary adenomatosis in man. *Arch. Int. Med.*, March, 1943, *71*, 403–409.

A pulmonary lesion of sheep, apparently of infectious origin, but resembling a tumor in its morphologic characteristics has been known since about 1891. It has received such varying

names as jagziekte, epizootic adenomatosis, pulmonary adenomatosis and infectious adenomatosis. Very similar and probably identical conditions have been reported under the titles of verminous pneumonia and Montana progressive pneumonia of sheep. A considerable incidence has been found in areas as widely separated as South Africa, Saxony, England, Iceland and Montana.

A case of pulmonary adenomatosis in man resembling somewhat the disease of jagziekte as found in sheep is presented. Roentgen examination of the chest showed some soft patchy mottling throughout the left middle and lower lung fields, although no large areas of consolidation were seen. On the right there was a great deal of soft opacity, almost completely obscuring the aerated lung except for some air in the apex and peripherally at the base. The patient died and an autopsy was performed. When the chest was opened the right lung was quite heavy and felt firm; it was subcrepitant and full of irregular nodules beneath the pleura. The cut surface was in most areas pinkish-yellow, smooth and meaty in appearance with fine strands of gray-white tissue separating great numbers of closely packed round and polygonal nodules of a few millimeters to several centimeters in diameter. The left lung showed similar but much less extensive nodularity beneath a perfectly smooth pleura and was generally subcrepitant to crepitant. The trachea and bronchi were filled with a frothy, brownish fluid and their mucosa was somewhat injected.

On microscopic study the nodules seen grossly seemed to be formed by portions of lung tissue which contained their normal alveolar skeleton. The normal alveolar epithelium had been replaced by high cuboidal and columnar cells. Generally the alveoli were lined by only a single layer of cells; in one or two isolated spots there seemed to be a slight anaplastic tendency with the formation of tiny nests of polyhedral cells within an alveolar lumen. The epithelial cells themselves possessed a granular cytoplasm, staining moderately heavy with eosin and a large vesicular nucleus usually located just below the middle of the cells but occasionally at either end.

Current opinion suggests that jagziekte is an infectious disease possibly of virus origin. A few similar human cases have been previously reported, so that it would seem that multiple, bilateral pulmonary adenomas may occasionally develop in man resembling morphologically those found in the ovine disease mentioned. While the evidence to support it is slight, there must be considered the possibility that this lesion as seen in sheep possesses neoplastic characteristics as well as transmissibility. The identity of the condition found in man with that found in sheep is not established by available evidence but further investigation seems indicated when opportunity presents.—*J. J. McCort.*

ROENTGEN AND RADIUM THERAPY

Maino, Charles R., and Mussey, Robert D. Carcinoma of the cervix coincident with pregnancy. *Am. J. Obst. & Gynec.*, Feb., 1944, *47*, 229–244.

A study of 3,570 cases of carcinoma of the cervix observed at the Mayo Clinic in approximately thirty-two years revealed that pregnancy was present in 26, or 0.7 per cent, of these cases when the carcinoma was found. The following statements are included in a summary of the study of these 26 patients.

1. The average age of the patients in the 26 cases in which carcinoma of the cervix was coincident with pregnancy was 32 years. The youngest patient was twenty-five years of age and the oldest patient was forty-one years of age. The prognosis was no worse in the case of young patients than it was in cases in which the patients were older.

2. The average number of previous pregnancies was 6 and the average number of children was 4. The number of pregnancies apparently did not affect the prognosis. In cases in which the carcinoma was diagnosed in the later months of pregnancy, the lesion usually was well advanced and the prognosis was poor.

3. Pregnancy may occur after carcinoma of the cervix has developed. A family history of carcinoma was elicited in 7, or 35 per cent, of the 20 cases which were observed five or more years prior to 1941. The prognosis in these 7 cases was better than the prognosis in the remaining cases.

4. Bleeding was the initial symptom in 23, or 88.5 per cent, of the cases. In 25 per cent of the cases, the patients did not realize that they were pregnant when the diagnosis was made.

5. No definite conclusions can be drawn con-

cerning the relative value of radiation therapy: however, it appears that operation is preferable in cases in which the lesion is operable and that supplementary irradiation increases the percentage of good results. This is in contrast to the relative value of radiation therapy and hysterectomy in cases of carcinoma of the cervix in which the patients are not pregnant.

6. The authors are in general agreement with Strauss concerning treatment of carcinoma of the cervix coincident with pregnancy. If the extent of the lesion permits operation and if the fetus is not yet viable, total hysterectomy is followed by irradiation; if the lesion is operable and the fetus is viable, cesarean section is followed by panhysterectomy and postoperative irradiation.

7. In cases in which the lesion is non-operable and the fetus is viable, cesarean section is followed by irradiation; in cases in which the lesion is nonoperable and the fetus is not yet viable, sufficient irradiation is employed to treat the lesion; incidentally, abortion occurs.

8. In cases in which the lesion is operable, total abdominal hysterectomy has produced the best results. In 57 per cent of the cases in which this procedure was employed, the patients were free of recurrence five years after the operation.

9. In this series of cases of carcinoma of the cervix coincident with pregnancy, many of which were observed before the present methods of treatment were developed, the prognosis appeared to be at least as favorable as the prognosis of carcinoma of cervix that is not associated with pregnancy. Of the 20 patients who were followed, 30 per cent were free of recurrence five or more years after they had been treated at the Clinic.—*Mary Frances Vastine.*

Sandler, Bernard. A preliminary note on the planning of combined radiotherapy of carcinoma cervix uteri. *Brit. J. Radiol.*, Nov., 1943, *16*, 331–337.

Charts and diagrams are given of a proposed method for combining roentgen and radium irradiation in the treatment of carcinoma of the cervix. An attempt is being made to develop a routine procedure. These preliminary investigations are only a first step towards a practicable solution of the problem of accurate radiotherapy in the pelvis. It is not yet ready for use as a routine procedure but a study of the charts and diagrams will show what has been accomplished so far. Further work is being done in an attempt to perfect the method.—*Audrey G. Morgan.*

Behney, Charles A., and Howson, John Y. Carcinoma of the cervix, end results. *Am. J. Obst. & Gynec.*, April, 1944, *47*, 506–513.

This report, based on the histories of 580 patients suffering from carcinoma of the cervix, demonstrates the value of high voltage roentgen therapy in the treatment of this disease. The importance of the later observations is enhanced by comparing these results with those of an earlier report concerning 437 patients; a grand total of 1,017 women suffering from cancer of the cervix, who died on the radiologic service of the Philadelphia General Hospital since 1922. Stage IV lesions, treated with external irradiation of high voltage roentgen therapy alone, lived longer than those treated with lightly filtered radium alone. The best results, however, were secured in the group, who, after regression of the primary lesion had been brought about by preliminary high voltage roentgen therapy, were subsequently treated with heavily filtered radon at a distance of 1 cm. Since this fact became apparent, it has become the authors' policy to administer external high voltage roentgen therapy preliminary to the radon application in every case of carcinoma of the cervix. The longer duration of life in patients in the recent series who were treated with high voltage roentgen therapy, regardless of the stage of the disease, can probably be attributed to the fact that these were given more adequate dosage than those of the earlier study.

Summary

1. When the general condition of the patient permits, every case of carcinoma of the cervix should be treated with some form of radiation therapy.

2. External high voltage roentgen therapy is always beneficial and safe for even the most advanced stages of the disease.

3. In many apparently advanced lesions, preliminary roentgen therapy will result in sufficient regression of the lesion that radon may be subsequently applied to great advantage.

4. Heavily filtered radon applied at a distance of 1 cm. results in better palliation than the highly filtered radon in contact application.

5. By observing the duration of life after admission to service in patients who died from

carcinoma of the cervix, a satisfactory indication of the value of various forms of therapy can be obtained.—*Mary Frances Vastine.*

MCINTOSH, HARRIET C. Roentgen therapy of pelvic tuberculosis in the female. *Radiology*, Jan., 1944, *42*, 48–55.

The comparative merits of surgical and radiation therapy in tuberculosis of the female pelvis are discussed. Surgeons generally prefer operation for operable cases but arguments against surgery are an operative mortality of 7 to 8 per cent, the occurrence of postoperative fistulae in 5 to 10 per cent, the possible production of miliary tuberculosis, the danger of injury to the bladder and rectum and the possibility that tuberculous tissue may be left behind. When the tubes are definitely diseased, the treatment of choice is their surgical removal followed by irradiation. When the endometrium alone is diseased without involvement of the tubes primary irradiation is probably the best method, including the tubes in the treated field because there may be slight involvement. In advanced disease of the tubes and peritoneum, laparotomy should be used for diagnosis and removal of fluid or necrotic tissue, followed by irradiation. Roentgen treatment has no effect on pyosalpinx, ascitic fluid or abscess material. It should not be used in pregnancy. In peritoneal tuberculosis it is most effective in the dry form with moderate plastic exudate. Case histories illustrating the different forms of pelvic tuberculosis and their treatment are given.

The author discusses the 11 cases she has treated. In irradiation, the abdomen should be divided into small fields. Ten years ago she gave 300 r (in air) at a dose, but now she gives 75 to 100 r, following the general trend toward smaller doses. Treatments of the same field are not given oftener than once a week, though treatment to different fields may be given two or three times a week if the fields are small.

The techniques of other workers are discussed. There were multiple foci in all her cases. Six of the patients are still free of disease one to three years after treatment and 4 more show local improvement, though the treatment is not considered successful. One patient showed little improvement. Irradiation is particularly effective in localized recurrences following surgical operation.—*Audrey G. Morgan.*

MANDEVILLE, F. B., and HOWE, JOHN S. Giant-cell tumor of the lower femur; case report with roentgen and pathological findings before and after curettage and roentgen therapy with amputation for sarcoma. *Radiology*, Jan., 1944, *42*, 56–63.

A case is reported in a man of fifty who came for treatment because of pain and swelling of the right knee of two months' duration. Six months before his right leg had given way while he was at work. Biopsy material aspirated and examined microscopically showed the picture of benign giant cell tumor. Curettage followed by roentgen treatment was given and the patient remained well for two and a half years, when pain began again. Three years after the first operation a second curettage was done and the microscopic findings showed pleomorphic sarcoma. Amputation was performed and the patient was well and free of recurrence five years later.

The possibility of malignant degeneration of benign giant cell tumor is discussed. Microscopic diagnosis of benign giant cell tumor does not guarantee that malignant giant cell tumor or sarcoma may not be found at a later date. And the finding of giant cell tumor by aspiration biopsy does not necessarily exclude sarcoma.

The value of roentgen treatment in this form of tumor is discussed. It appears from the literature that there are fewer recurrences after complete excision with bone graft or amputation than after curettage or curettage and roentgen treatment. The end-results of treatment in all cases of benign giant cell tumor should be reported in order to arrive at a reliable judgment as to the value of irradiation in this form of tumor. From the evidence so far the authors do not believe that irradiation should be used at all in the treatment of benign giant cell tumors.—*Audrey G. Morgan.*

MISCELLANEOUS

LEVI, SAM. Determination of the position of calcium deposits and foreign bodies from stereoscopic films without the use of a viewing stereoscope. *Radiology*, Jan., 1944, *42*, 71–73.

Some persons have poor stereoscopic vision; for these and for those who wish to check the accuracy of their stereoscopic findings, it is desirable to have a method of determining the depth of shadows caused by calcium deposits or foreign bodies by direct measurement. Such a method is described in which the only appara-

tus necessary is a common centimeter ruler. The method of making the measurement and the working out of the geometrical equation for the figure are given.—*Audrey G. Morgan.*

Lea, D. E. The spatial distribution of ionization in irradiated tissue and its relation to biological effects. *Brit. J. Radiol.*, Nov., 1943, *16*, 338–339.

Experiments in the production of chromosome aberrations in irradiated microspores of *Tradescantia* are described which seem to show that the spatial distribution of ionization in irradiated tissue is definitely related to biological effects. A curve of anticipated efficiency (for equal ionization in tissue) of roentgen-ray wavelengths ranging from 1 to 10 A has been constructed. The predictions based on these calculations were tested by making irradiations at wavelengths 0.15, 1.5, 4.1 and and 8.3 A. The agreement obtained was satisfactory.

This type of action is a direct action of irradiation and must not be confused with the indirect type in which the radiation ionizes some common cell constituent, probably water, activating the water, and the activated water then produces the biological effect. The spatial distribution of ionization is best understood in the direct type of action.—*Audrey G. Morgan.*

Goldmann, Carl H. Tomographic attachment suitable for most x-ray plants. *Brit. J. Radiol.*, Nov., 1943, *16*, 355–356.

Deep-seated abscesses which are hard to locate are common among soldiers in tropical Africa. The special tomographic equipment cannot be used in military hospitals. Twining and Bush have designed tomographic attachments which, however, have the disadvantage that they must be used with the patient lying down and also that there is a rigid combination between the Potter-Bucky diaphragm and the tomographic movement levers.

The author describes and illustrates an apparatus by means of which tomography can be carried out with almost any existing roentgen-ray apparatus with the patient in either the horizontal or vertical position, and with or without a mobile or stationary grid. It is simple in structure, cheap, small in size and light in weight. While the results are not, of course, equal to those of the special tomographic equipment, they compare favorably with those obtained by the Twining and Bush attachments. It has been used successfully for localizing deep pulmonary and liver abscesses, encysted effusions and for the localization of nonmetallic foreign bodies. There is a small depth gauge for determining accuracy of depth.—*Audrey G. Morgan.*

Nettleship, A. Tissue changes produced in C3H mice by 50 r whole body exposure. *Radiology*, Jan., 1944, *42*, 64–70.

Little attention has been paid to the effects of small doses of roentgen rays. The author therefore irradiated C3H mice from an inbred colony with 50 r applied to the whole body and studied the effects. The effects on the blood picture are shown by curves and photomicrographs of the effects on the tissues are reproduced. The blood showed a transitory leukocytosis followed after eight to twelve hours by a mild but persistent lymphopenia. The tissue cells showed swelling and eosinophilic staining of the cell cytoplasm with decreased staining of the nuclei; later slight hyperchromia of the cell and nucleus with final return to normal. There was destruction of cells in the lymph node follicles followed by a slight hyperplasia. Changes in the bone marrow were less pronounced and occurred later than those in the lymph nodes. There was edema of the mucosa of the lower ileum. There was destruction of spermatogenic cells and a reduced rate of mitosis with slow return to normal.

As these changes are only slight they may be regarded as threshold effects of irradiation. The different effects appeared at different times and lasted for varying periods. The damage suffered was mild and there was an early return to normal.

It is evident that definite changes are caused by doses as low as 50 r applied to the whole body of the mouse. A lymphocyte count of the peripheral blood will show threshold tissue damage due to irradiation when a leukocyte or neutrophil count fails to show it.

In the discussion Dr. Henshaw called attention to the fact that a dosage of 50 r may easily be received by roentgen-ray workers and that the cumulative effect of such doses may cause serious injury.—*Audrey G. Morgan.*

Hilding, A. C. The role of ciliary action in production of pulmonary atelectasis, vacuum in the paranasal sinuses, and in otitis media. *Ann. Otol., Rhin. & Laryng.*, Dec., 1943, *52*, 816–833.

In the article, the author describes the experiments which he performed, some at the University of Wisconsin in the Department of

Pathology and others in the Institute of Experimental Medicine. He includes the following observations in the summary:

1. The steps in the development of postoperative pulmonary atelectasis are about as follows:
   a. An excess of secretion is formed within the affected lobe.
   b. A succession of occluding masses, or pistons, of mucus form across the lumina of the air passages.
   c. These "pistons" move up the cylindrical air passages by ciliary action, each carrying in a quantity of air.
   d. As soon as the pressure within the lobe begins to fall, it shrinks by its own elasticity and from pressure by adjacent lobes.
   e. The adjacent lobes carried by the force of inspired air move into the space relinquished by the affected one.
   f. The advancing pistons rupture serially as they reach tubes of greater diameter and meet more forceful changes of air pressure. Each then releases the bubble of air which it carried and continues on its course as a mural mass of film.
   g. A negative pressure of considerable proportion is produced within the lobe when the supply of air is exhausted.
   h. The masses of secretion then present in the air passages come to a standstill when cilia can no longer advance them against atmospheric pressure.
   i. The cilia continue to remove secretion from these "stalled" masses in thin films and might eventually remove them entirely if they were not replaced by continued secretion.

2. Negative pressure can be produced within a normal sinus by the introduction of a quantity of mucus which replaces a portion of the contained air. When sufficient mucus has reached the ostium by ciliary action to completely fill it so that incoming air cannot pass by, negative pressure develops in the sinus. The pressure falls as the mucous mass is progressively dragged and pushed through the ostium. When the effective power of the cilia is equalled by the difference between atmospheric pressure and the pressure within the sinus, the mass ceases to advance and the pressure ceases to fall. The cilia continue to act and remove the mucus in thin films. When sufficient mucus has been removed, atmospheric pressure forces air through the ostium into the sinus again.

Negative pressure almost certainly develops clinically in sinuses when they are more or less filled with mucus and when their cilia are active.

3. The negative pressure, which is known to occur within the middle ear, is probably due to the force of ciliary action moving mucus down the eustachian tube.—*Mary Frances Vastine.*

Burrows, Harold, and Clarkson, J. R. The role of inflammation in the induction of cancer by x rays. *Brit. J. Radiol.*, Dec., 1943, *16*, 381–382.

Early in this century cancer developed on the hands of many radiologists and technicians. This led to a study of the factors that might help in the production of such cancerous growths. The authors describe experiments made on rabbits to determine whether inflammation played any part in the causation of such tumors. They produced inflammation in the groins of 18 rabbits and gave them a single irradiation of 600 or 2,000 r. Sarcoma developed at the site of irradiation in 13 of these 18 rabbits. Only those rabbits which survived irradiation for as long as twenty-two months are considered. Twelve rabbits were irradiated with the same doses without any preceding inflammation; tumor did not develop at the site of the irradiation in any of these animals nor in any of those that were irradiated with a dose of only 250 r. Nine guinea pigs were similarly irradiated and cancer did not develop in any of them, no matter whether they had previous inflammation or not.—*Audrey G. Morgan.*

Mitchell, J. S. Metabolic effects of therapeutic doses of x and gamma radiations. *Brit. J. Radiol.*, Nov., 1943, *16*, 339–343.

Experiments are described and the results summarized which show that significant disturbances of both carbohydrate and nucleic acid metabolism are produced by therapeutic doses of roentgen and radium irradiation, probably by means of inactivation of enzymes. Tables showing the detectable effects of roentgen and radium irradiation are given.—*Audrey G. Morgan.*

Fleming, J. A. C. Investigations into the degree of scattered radiation received by x-ray workers during routine diagnostic examinations in a military hospital department. *Brit. J. Radiol.*, Dec., 1943, *16*, 367–370.

If an operator does not expose himself to

the direct beam from a roentgen tube, the chief source of radiation to which he is exposed is scattered radiation from the body or part of the patient through which the roentgen-ray beam is passing. With a view to determining the amount of such radiation, experiments were carried out at a military hospital, the measurements being made with a Hammer dosimeter with a special ionization chamber which has been described before.

The measurements showed that under normal working conditions a roentgenographer unprotected by any lead screen or other protective device can safely stand at a distance of 2½ feet or more from the center of the field of irradiation in the patient; at this distance he will not receive an overdose of scattered radiation from the body of the patient. When roentgenograms are taken during fluoroscopic examination the operator should stand about 5 feet from the center of the field of irradiation while the roentgenograms are actually being made. This is not necessary if the greater part of the body of the operator is protected by a lead screen or apron.—*Audrey G. Morgan.*

Ungar, E. M. Efficiency of radiation and homogeneity. *Brit. J. Radiol.*, Dec., 1943, *16*, 376–380.

Since the introduction of radiotherapy there has been a constant effort to improve the therapeutic effects of irradiation of deep tumors. Mayneord and Happey have suggested rules for applying the integral dose throughout the tumor irradiated. It has been found that homogeneity of the tumor dose throughout the tumor is desirable for in this way the required minimum tumor dose can be applied throughout the growth. If the fields used are too large and a homogeneous dose is given throughout the tumor the integral dose will be too high. If the size of the fields is reduced and their shapes adapted so as to cover the tumor adequately and homogeneity is achieved it leads to great economies in the integral dose. The reduction of field size is limited by the fact that every single field should cover the whole tumor volume and by the degree of accuracy possible in estimating the size and location of the malignant growth; that is, the less precise the knowledge of its extent, the larger the fields must be in proportion to the size of the tumor. Diagrams and formulae used in the working out of these propositions are given and also diagrams of a case of carcinoma of the cardia illustrating the effect homogeneity has on economy of irradiation in practice.—*Audrey G. Morgan.*

Roberts, J. E., and Farmer, F. T. An x-ray output meter. *Brit. J. Radiol.*, Nov., 1943, *16*, 353–354.

The technique of measuring a beam of roentgen rays at the opening of the tube has been utilized in some therapy equipments but these instruments have, as a rule, been quite delicate and have not proved as reliable as necessary for clinical work. An instrument is described which seems to meet all requirements at a minimum of cost and equipment.

The basis of the instrument is an ionization chamber fitted into the tube aperture through which the rays pass. The current through the chamber, when saturation is maintained in it, is then a measure of the intensity of the beam. A simple robust valve voltmeter system is used. The circuit is illustrated and the ionization chamber and the temperature compensation system described in detail. For reference purposes this instrument is called the M. H. x-ray output meter.—*Audrey G. Morgan.*

Williams, Marvin M. D. Recovery of radium tubes from sewer. *Radiology*, Nov., 1943, *41*, 478–482.

Three small tubes of radium each containing approximately 50 mg. radium sealed inside a glass tube which was in turn sealed inside a tube of monel metal were removed from a patient and misplaced. Their loss was not discovered until an hour later. The hospital rooms and grounds were checked with a portable Geiger-Müller counter and then the hospital and city sewers checked. The tubes were not found and then sewer scrapers which are illustrated were used. Finally a wadded-up truck tire chain was dragged through the sewer and one of the tubes found six weeks after their loss. The sewer scraper was then pulled through the same section of sewer and the second tube located. But the third could not be found. An electrometer was then used and the approximate position of the third tube determined and it was then removed with a smaller scraper. There was a deposit that looked like coal-dust in this section of the sewer that had caught the tube and prevented its being removed by the larger scraper.

Other possible methods of locating radium in sewers are discussed.—*Audrey G. Morgan.*